

AN ABSTRACT OF THE THESIS OF

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Title: Risk of Work-related Musculoskeletal Disorders among Surgeons:
Comprehensive Question Pool Development and a Pilot Study

Abstract approved:

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Work-related musculoskeletal disorders (WMSDs) are prevalent among surgeons due to a variety of risk factors. Various subjective tools have been used to investigate the associations between these risk factors and their contributions to the development of WMSDs. This study aimed to provide a summary of a collection of popular subjective tools, including their applications and risk factors investigated using these tools, and to develop a comprehensive question pool and general guidelines to assist researchers to select tools based on their research interests. Furthermore, the developed comprehensive question pool was used to create a questionnaire and investigate the risk factors associated with developing WMSDs among surgeons with experience of performing a variety of surgical procedures.

A systematic literature review was performed using six electronic databases. Articles that met inclusion criteria were investigated thoroughly. Questions were categorized based on the categories of risk factors and outcome

measurements to create the comprehensive question pool. The results of the systematic review indicated that among 60 articles meeting inclusion criteria, 10 standard, 5 modified version, and 18 self-developed tools were recognized. The NASA-TLX and Nordic Musculoskeletal questionnaires were the most popular tools. Four groups of risk factors were identified: physical, cognitive, psychosocial, and individual factors. Physical and individual risk factors have received more attention compared with the psychosocial and cognitive risk factors. It was also found that investigating the short-term outcome measurements, such as discomfort, got more attention comparing the long-term ones.

The second objective of this study was to use the developed comprehensive question pool to create a questionnaire and investigate the risk factors associated with developing WMSDs among surgeons. Seven surgeons from local hospitals participated in the pilot study. They answered to the questions about each of the categories of risk factors. The results of the questionnaire indicated that the levels of risk factors are different while performing different surgical procedures of open, laparoscopic, and robotic. The results also showed that surgeons who are aware of ergonomic guidelines experience discomfort in fewer regions of their bodies after performing surgeries.

The results of this study indicated that only a few tools can be used to investigate the risk factors from all four categories of the risk factors. Moreover, risk factors from different groups got different levels of attention. Using the developed comprehensive question pool helped us to create a questionnaire

more efficiently to investigate the risk factors associated with developing WMSDs thoroughly. The results of the survey itself showed the association between the risk factors and prevalence of discomfort among surgeons and different levels of risk of performing different surgical procedures. The results also indicated the importance of ergonomic guidelines awareness in reducing the risk of developing WMSDs among surgeons. Since most of risk factors included in these tools are very common among various occupations, the general guidelines developed in this paper can be used by researchers who are interested in reducing the risk of the development of WMSDs among surgeons and workers in other occupations.

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Risk of Work-related Musculoskeletal Disorders among Surgeons:
Comprehensive Question Pool Development and a Pilot Study

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Kiana Kia, Author

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1. CHAPTER 1: INTRODUCTION

1.1. Prevalence of work-related musculoskeletal disorders

Musculoskeletal disorder is defined as “damage caused by physical trauma sustained by tissues of the body” (Whiting & Zernicke, 2008). Workplace design plays an essential role in the development of musculoskeletal disorders. When the work design forced a worker to do a task outside his/her body’s capabilities and limitations, he/she is going to be at risk of work-related musculoskeletal disorders (WMSDs). The U.S. Department of Labor considers the musculoskeletal disorders that has been caused or aggravated due to some conditions in the work environment as “Work-related” musculoskeletal disorders. The U.S. Department of Labor reported that WMSDs accounted for 31% of all injuries and illness cases in 2015 with 356,910 cases (BLS, 2016).

WMSDs are prevalent among a variety of different occupations, such as those in manufacturing, construction, and health care (Bernard et al., 1997). In 2015, 113.6 cases of days-away-from-work incidents per 10,000 full-time workers were reported in healthcare and social assistance section, which is the highest rate of cases among all of the private industry sectors (BLS, 2016). Nurses and other health care professionals who work directly with patients, involving with patient handling, have received the highest attention by researchers. (Marras, Davis, Kirking, & Bertsche, 1999; Marras, Knapik, & Ferguson, 2009; J. Smedley, Egger, Cooper, & Coggon, 1995; Julia Smedley et al., 2003).

Relatively fewer studies have investigated WMSDs among surgeons. Almost 80% of the 284 surgeons participants in Wauben et al.'s study reported discomfort in the neck, shoulders, and back (2006). Another study on general surgeons indicates high prevalence rate of WMSDs mainly in neck, low back, shoulder and upper back (Grace P. Y. Szeto et al., 2009). Another study indicates that pediatric surgeons frequently experience shoulder pain and use painkillers (Ciro Esposito et al., 2013). Mirbod et al. conducted a survey among orthopedists and general surgeons, and reported high prevalence of subjective complaints about musculoskeletal pain in shoulder and lower back (1995). The result of another survey among North American members of the American Society of Pediatric Otolaryngology shows that 62 percent of the respondents experience pain or discomfort that they attribute to their surgical practice (Cavanagh et al., 2012). These types of pain and discomfort can be anticipated among other surgeons with different specialties as well.

In addition to some of the physical aspects of the surgeons' work that have been examined in previous studies, the influence of psychosocial risk factors has been also explored. Szeto et al.'s study indicates that physical and psychosocial factors are highly correlated with the musculoskeletal symptoms in surgeons (Szeto et al., 2009).

Surgeons' demanding jobs impose various physical and psychosocial stress on them and put them at risk of developing WMSDs. Surgeons' injury can have adverse effect on surgeons' living, patients, and institutions in different ways (Davis, Fletcher, & Guillamondegui, 2014). Therefore, it is very important to recognize the risk factors contributing to surgeons' injury and use appropriate tools to assess these factors.

1.2. Risk Factors associated with WMSDs

The results of a critical review developed by National Institute for Occupational Safety and Health (NIOSH) indicates that physical factors, psychosocial factors, and individual factors are the risk factors contributing to the development of WMSDs of the upper extremity and the low back (Bernard, 1997). In addition, the cognitive factors are another category of risk factors contributing to development of WMSDs (Iwanaga, Saito, Shimomura, Harada, & Katsuura, 2000; Mehta & Agnew, 2011; Splittstoesser, Marras, & Best, 2011). Figure 1 illustrates the four main categories of risk factors in the development of WMSDs.

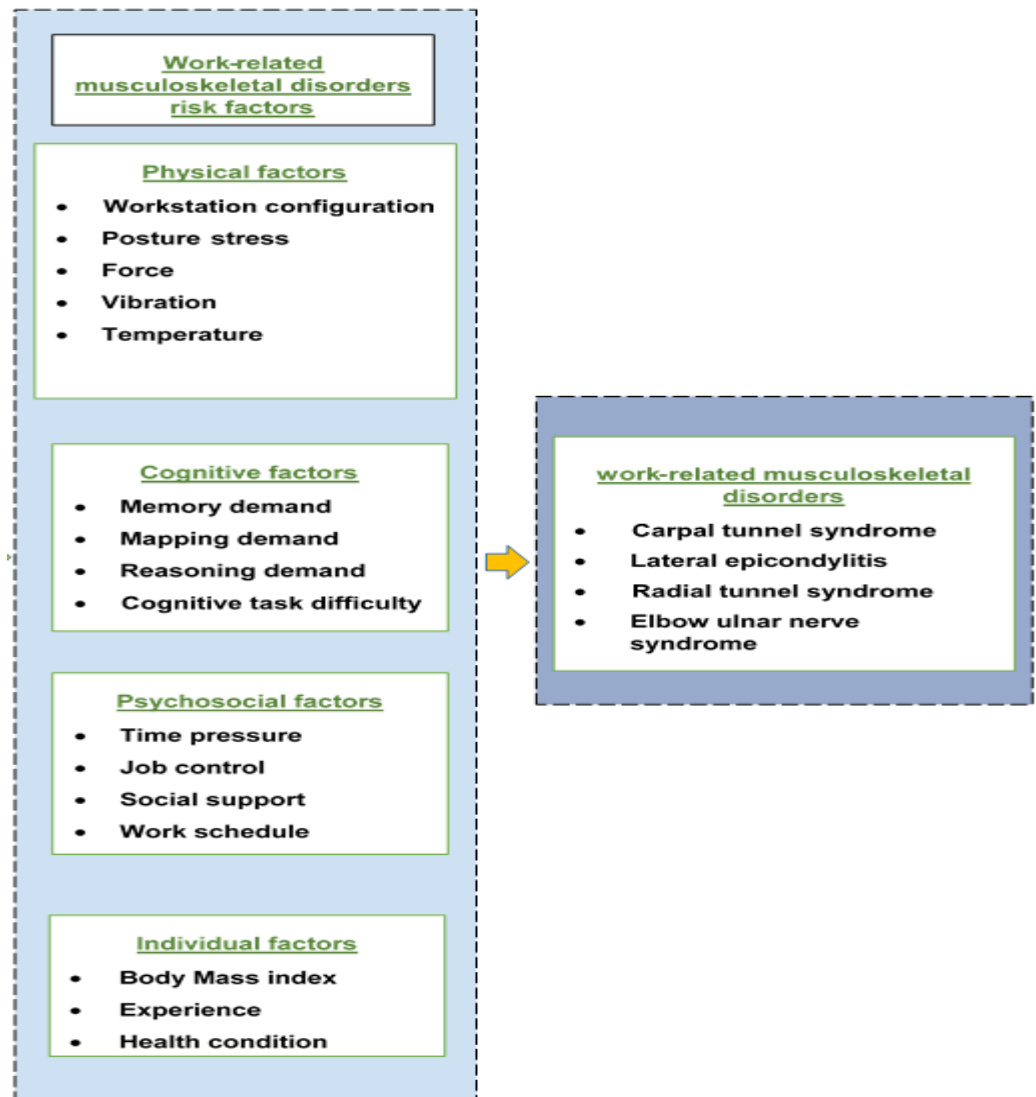


Figure 1 Risk Factors Associated With the Development of Work-Related Musculoskeletal Disorders

1.2.1. Physical factors

Physical risk factors are characteristics of the work environment that put workers at risk of developing WMSDs. Repetition, force, posture, vibration, static posture, and workstation configuration are commonly cited in literature (Bernard, 1997; Malchaire, Cock, & Vergracht, 2001a; Wærsted, Hanvold, & Veiersted, 2010). Physical characteristics of surgical environment like workstation configuration (e.g.,

height of bed, height of chair, distance from the visual display, etc.), posture stress (e.g., duration and frequency of awkward posture), force, vibration, temperature, light, noise and surgical instruments have been found to be significantly associated with the WMSDs among surgeons. (Berquer, Smith, & Davis, 2002; Houvet & Obert, 2013; G. Lee et al., 2008). In Berquer et al.'s Study, it has been shown that table height, as one of the parameters of the work station settings, can affect the level of discomfort (2002). The results of a study indicates that different levels of table height can impose different levels of muscle activation and mental workload on surgeons performing laparoscopic and suggests an approximate table height of 64 to 77 cm above floor level to minimize physical and mental workload (Berquer et al., 2002). It has been shown that awkward posture of surgeons like holding trunk and neck twisted for a long period of time increase fatigue and muscle pain in different body parts in upper and lower extremity of surgeons (Roja, Kalkis, & Roja, 2015a).

1.2.2. Cognitive factors

Cognitive factors are characteristics of the tasks that represent their load on individuals' cognitive systems and their cognitive demand to accomplish goals (Danili & Reid, 2006; Paas & Merriënboer, 1994). Cognitive factors, such as Memory demand, mapping demand, and reasoning demand, can directly affect human information process systems. In addition to these direct cognitive risk factors, the level of task difficulty can increase cognitive workload. High level of task difficulty can increase muscle load and result in MSDs in long run. The results of the previous studies indicate that performing different surgical procedures, like standard and robotic assisted laparoscopic, requires different levels of cognitive expenditure, as well as physical

expenditure, which can result in fatigue (Hubert et al., 2013b). In a study on mental stress and workload, tonic skin conductance level (SCL), electrooculogram (EOG), and subjective reports of concentration (CON) and stress (STR), were measures and the results indicated that mental workload and stress were higher while performing video-endoscopic surgeries in comparison to open surgeries (Berguer, Smith, & Chung, 2014).

1.2.3. Psychosocial factors

Psychosocial risk factors are characteristics of the work organization that can increase workload and can be considered as one group of the contributing factors to the development of WMSDs (Bernard, 1997; Bourbonnais, Comeau, Vezina, & Dion, 1998). Time pressure, job control, social support, work schedule, and other psychosocial stress that increase workload are parameters of psychosocial risk factors. For example, it has been shown that there is an association between low job control and WMSDs of lower back and lower limb among healthcare workers (Koehoorn, Demers, Hertzman, Village, & Kennedy, 2006). Psychosocial variables are associated with the risk of WMSDs among surgeons as well. Szeto et al. investigated the effects of psychosocial factors, such as job control and work schedule, on the development of WMSDs among surgeons and the results indicate the association between these two variables (2009).

In addition, awareness of ergonomics guidelines is another parameter of psychosocial risk factors. Organizations have the responsibility of increasing ergonomic guidelines awareness among surgeons and providing appropriate means for applying those guidelines. In a survey study among 284 surgeons it has been shown that almost 80% of the respondents had experience pain in neck, shoulders, and back

and 89% of the respondents were unaware of ergonomic guidelines and all of the respondents found ergonomic guidelines to be important (Wauben, van Veelen, et al., 2006). Surgeons who have information regarding the risk factors and ergonomic guidelines are less exposed to experiencing musculoskeletal symptoms (Miller, Benden, Pickens, Shipp, & Zheng, 2012).

1.2.4. Individual factors

Individual factors are related to surgeons' genetic and demographic characteristics as well as the surgeons' medical history that indicate individual's vulnerability to developing WMSDs. Individual factors, such as body mass index (BMI), experience, gender, and previous health condition, have been reported to significantly influence workload and risk of WMSDs (Houvet & Obert, 2013). Regarding gender, some studies indicate that females and males react differently to physical and psychosocial risk factors (Hooftman, van der Beek, Bongers, & Van Mechelen, 2005). It has even been investigated that males are more vulnerable to exposure to WMSD, on the contrary of what was expected (Hooftman, Van Der Beek, Bongers, & Van Mechelen, 2009). On the other hand, some other studies indicate that there is no differences between males and females performing the same tasks. So, they do not consider gender as a risk factor (Hughes, Babski-Reeves, & Smith-Jackson, 2007; Malchaire et al., 2001a). Regarding age as one of the risk factors, old people tend to compensate for their reduced neck and trunk flexion by keeping and holding awkward posture and experiencing musculoskeletal discomfort (Chateauroux & Wang, 2008).

The effects of individual factors, such as age, gender, BMI, and title and their association with musculoskeletal symptoms on ten body parts of nurses have been studied. It has been shown that nurses' smoking habit, BMI, and work experience are significantly associated with musculoskeletal symptoms (Daraiseh, Cronin, Davis, Shell, & Karwowski, 2010). A Study among health care workers shows that people with a recent history of injury are at higher risk of developing WMSDs (Koehoorn et al., 2006). Another study among emergency medical services professionals indicates that individuals with excellent health condition report recent pain in their low backs less frequently, in comparison with individuals with fair or low health condition (Studnek, Crawford, Wilkins III, & Pennell, 2010). It has been shown that laparoscopic surgeons with less experience with performing laparoscopic surgery experience more workload (Montero, Acker, Heniford, & Stefanidis, 2011).

1.2.5. Interactions between risk factors

Previous epidemiological studies shows the association between four groups of risk factors and developing WMSDs (Bongers, de Winter, Kompier, & Hildebrandt, 1993; Malchaire et al., 2001a; Julia Smedley et al., 2003). According to the literatures studying these four groups of risk factors in developing WMSDs, there can be some interactions between these groups of risk factors (Bernard, 1997; Griffiths, Mackey, & Adamson, 2007). It has been shown that there is an association between physical risk factors and cognitive risk factors, as it has been found that working in complex workplace can increase muscles load and risk of developing WMSDs (Au & Keir, 2007; Mehta & Agnew, 2011). Also, It has been shown that the interaction between physical and psychosocial factors can increase risk of developing WMSDs (Hughes et al., 2007;

V. Johnston, Jull, Souvlis, & Jimmieson, 2010; Joling, Blatter, Ybema, & Bongers, 2008). In addition, It has been shown that the combination of cognitive factors and psychosocial factors can result in WMSDs (Hughes et al., 2007).

1.3. Risk factors of performing different surgical techniques

Surgeons use a variety of surgical techniques to perform surgery. Conventional open, laparoscopic, and robotic surgery are examples of surgical techniques that surgeons apply. Open surgery is the conventional type of surgery in which surgeons use scalpel to make incision and use instruments to perform surgery. Laparoscopic surgery or minimally invasive surgery is a type of surgery in which smaller incisions are made and instruments with long handles are used to perform surgery. In order to perform laparoscopic surgeries, one or more monitors are used to display the view of the patient's body. In robotic surgeries, depend on the surgical console that is used, surgeons sit at surgical console while they have view of the patients' bodies and perform the surgery using the instruments at the surgical console.

Performing surgery using different surgical techniques can impose different levels of risk, since different instruments, workstation configuration settings, and posture are required while performing them. Previous studies have compared these surgical procedures in terms of the level of the risk factors of developing WMSDs among surgeons.

1.3.1. Open versus laparoscopic surgery

Previous studies show that performing laparoscopic surgery is physically more stressful than open surgery in general (Berguer et al., 2014). Performing laparoscopic surgeries requires surgeons to be involved in maintaining static posture,

while performing open surgery requires more dynamic movements (G. P. Y. Szeto et al., 2010). In laparoscopic surgeries, surgeons perform surgery with less degree of freedom in their movements because they are holding instruments with long handles while viewing the inside of patients' body with monitors. Laparoscopic surgeons have higher tendency to maintain static posture in neck, while the frequency and repetitiveness of maintaining awkward posture in neck is higher among open surgeons (Berguer, Rab, Abu-Ghaida, Alarcon, & Chung, 1997). In a study using a force plate, it has also been shown that the range of motion of the center of pressure is lower among laparoscopic surgeons compared with open surgeons (Berguer et al., 1997). As there is a significant association between duration of maintaining static posture and increase in the level of muscle activity, this factor can make laparoscopic surgical tasks more physically demanding (Grace P.Y. Szeto et al., 2012).

Laparoscopic surgeons maintain extended neck posture for a longer period in comparison to open surgeons. On the other hand, open surgeons hold more flexed neck posture (Berguer et al., 1997; Grace P.Y. Szeto et al., 2012). The higher level of muscle activities in right and left cervical erectors, shows higher physical demand in neck while performing open surgery compared with laparoscopic surgeons (G. P. Y. Szeto et al., 2010). On the other hand, previous studies show that the level of muscle activity and perceived discomfort in shoulder are higher while performing laparoscopic surgery compared with open surgery (Berguer R, Chen J, & Smith WD, 2003; Grace P.Y. Szeto et al., 2012). In terms of level of physical discomfort in forearm and hands of the surgeons, it has been shown that muscle activity in thumb and forearm flexor are higher

while performing laparoscopic surgery compared with open surgery, in addition to perceived discomfort level in flexor digitorum muscles (Berguer R et al., 2003).

In terms of mental stress, it has been shown that mental stress and effort are higher while performing video-endoscopic surgery (VES), as one type of minimally invasive surgery, in comparison with open surgery (Berguer et al., 2014). In Berquer et al.'s study, objective variables, such as tonic skin conductance level and electrooculogram were measured in addition to subjective measurements (2014).

1.3.2. Laparoscopic versus robotic

Based on the previous studies, performing robotic surgery is less demanding physically (Dalager, Søgaaard, Bech, Mogensen, & Jensen, 2016; Hubert et al., 2013b; Gyusung I. Lee et al., 2014). Studying the mental workload of performing surgery also indicates that mental workload is higher during laparoscopic surgery than robotic surgery among the experienced surgeons (Gyusung I. Lee et al., 2014).

The results of a study indicate that the level of muscle activity in cervical muscles is similar in laparoscopic surgery in comparison with robotic surgery (Grace P. Y. Szeto, Poon, & Law, 2012). The result of another study shows that perceived effort is higher while performing laparoscopic surgery in comparison with robotic surgeries (Gyusung I. Lee et al., 2014). However, the results of a pilot study shows that laparoscopic surgeons experienced less discomfort in neck, shoulder, and back in comparison with robotic surgery (Tarr et al., 2015).

Comparing muscle activity in the back muscles (dorso-lumbar) shows that muscle activity is lower while performing robotic surgery compared with laparoscopic

surgery (Hubert et al., 2013b). The study over the perceived effort also indicated less effort and stress in the backs of robotic surgeons compared with laparoscopic surgeons (Hubert et al., 2013b).

One of the previous studies shows that the level of fatigue and physical activity in trapezius muscle in laparoscopic surgeries is higher compared to robotic surgery (Grace P. Y. Szeto et al., 2012). However, the result was not consistent with other studies, which shows higher muscle activity in trapezius muscle and higher level of discomfort in shoulder among robotic surgeons compared with laparoscopic surgeons (Gyusung I. Lee et al., 2014; Tarr et al., 2015).

Comparing muscle activity in hands and arms of surgeons indicates less muscle activity in biceps, forearm and wrist extensors and flexors while performing robotic surgery compared with laparoscopic surgery (Gyusung I. Lee et al., 2014; Grace P. Y. Szeto et al., 2012).

1.4. Subjective tools for assessment of WMSDs among health care workers

Objective and subjective tools have been used by researchers to evaluate the mentioned risk factors. There is a variety of drawbacks related to using objective tools that makes subjective tools very valuable in research on WMSDs among surgeons. Objective tools are more expensive and less appropriate for studying large sample size in comparison to subjective technique.

Objective technique has been used in many studies. Goniometry, as one of the objective techniques, has been used for evaluation of the surgeons' posture stress (Sancibrian et al., 2014; Szeto et al., 2012b). Park et al. studied surgeons' spine posture

by attaching markers on surgeons' bodies and observing their posture during surgery (2012). Rapid Upper Limb Assessment (RULA) has been used to assess laparoscopic surgeons' upper body posture stress (Person, Hodgson, & Nagy, 2001; Youssef et al., 2011). Video analysis has been used vastly in studies of surgeons' posture stress (Det, Meijerink, Hoff, Veelen, & Pierie, 2008; Gillette, Quick, Adrales, Shapiro, & Park, 2003; Uhrich et al., 2002; Youssef et al., 2011). Electromyography has been also used to measure muscle activities in different muscles, including trapezius and cervical muscles (Hubert et al., 2013a; Grace P. Y. Szeto et al., 2012). Force plate has been used to measure the range of motion in center of pressure of surgeons while performing surgery (Berguer et al., 1997) .

Objective and subjective techniques can be used in both real operation and simulated environment. In real operation environment, researchers can conduct completely valid and realistic research on surgeons. However, they may face some difficulties like getting study equipment into the operating room and sterilizing it (Lee, Dexter, Klein, & Park, 2007). For example, in study of forearm muscle activities, it is impossible to attach electromyography electrodes on forearm of the surgeons and collect muscle activities (Grace P. Y. Szeto et al., 2012). Many studies have been conducted in real operation environment despite its difficulties. For example, surgeons' fatigue as well as upper limb, hand and neck postures of surgeons have been studied in real operation room (Butler et al., 2013; Det et al., 2008; Filisetti, Cho, Riccipetitoni, & Saxena, 2015; Szeto et al., 2012b).

Variety of subjective tools have been used to assess these risk factors and prevalence of WMSDs among surgeons. Physical risk factors associated with

developing WMSDs among surgeons have been assessed by tools, such as NASA-TLX, SURG-TLX, and Nordic. Subjective Mental Effort Questionnaire (SMEQ) has been used to assess cognitive risk factors, as well as NASA-TLX and SURG-TLX. In order to assess psychosocial factors, subjective tools have been used in the previous studies, such as a modified version of workstyle short form questionnaire. Questionnaires, such as Nordic and local experienced discomfort questionnaire (LED), contain questions regarding the individual risk factors and have been used to assess these types of risk factors among surgeons. Furthermore, some tools, like SAGES and physical discomfort survey, have been used to assess the short term and long term outcome measurements of performing surgical tasks, such as pain, discomfort, disabilities and WMSDs symptoms among surgeons (Berguer, 2014; Manukyan et al., 2007).

In the most of the previous studies using these subjective tools, the focus of the study was on studying the effects of either groups of risk factors and have paid less attention to the interaction between each groups of risk factors and their potential influence on the development of WMSDs. Several studies have focused on physical risk factors. For example, they have assess operating room settings, like patient table height, and its effect on Surgeons (Berquer, Smith, & Davis, 2001; Manasnayakorn, Cuschieri, & Hanna, 2009; Marcos, Seitz, Bubb, Wichert, & Feussner, 2006; Matern, Waller, Giebmeier, Rückauer, & Farthmann, 2001; J. Y. Park et al., 2012). In terms of cognitive risk factors, mental strain in surgeons performing two different surgical procedures of conventional open surgery and laparoscopic surgery has been studied and it has been shown that laparoscopic surgery can impose more mental strain than conventional open surgery (Böhm, Rötting, Schwenk, Grebe, & Mansmann, 2001).

Böhm et al. also studied the influence of surgeons' experience as one of the individual risk factors. It has been shown that less experienced surgeons have experienced higher mental workload and were less relaxed in comparison to experienced surgeons (2001). Physical risk factors and mental workload of surgeons performing surgery with different techniques and standing positions have been examined (Youssef et al., 2011). Szeto and her colleagues studied two groups of physical and psychosocial risk factors and their association and effects on development of WMSDs among surgeons (Grace P. Y. Szeto et al., 2009).

In addition to interaction between the risk factors, awareness of ergonomic guideline has not been studied the least among other psychosocial risk factors. Previous studies indicate that lack or low level of awareness of ergonomic guidelines is one of the contributing factors in the development of WMSDs, the risk of which can be reduced by training and raising awareness of ergonomic guidelines (Khan & Yee Chew, 2013). A study among dental students has shown that 93% of the students have experienced WMSDs and 77% of them were unaware of ergonomic guideline (Khan & Yee Chew, 2013).

Wauben et al.'s study indicates that surgeons find ergonomic guidelines very helpful in the decrease of physical discomfort while many of the surgeons are not aware of these guidelines (2006). In addition to Wauben et al.'s study, only few studies attempted to study ergonomic guidelines awareness among surgeons (Cavanagh, Brake, Kearns, & Hong, 2012a; G. I. Lee, Lee, Green, Allaf, & Marohn, 2016; A. Park, Lee, Seagull, Meenaghan, & Dexter, 2010; Wauben, van Veelen, et al., 2006).

Due to the low attention to the association between ergonomic guideline awareness and developing WMSDs and the interactions between the risk factors, there is a need to further investigate the associations between the awareness of ergonomic guidelines and the development of WMSDs. In order to investigate how awareness of ergonomic guideline can be a contributing factor to the development of WMSDs, the study should not be limited to asking surgeons if they are aware of the guidelines. I also need to develop questions to address following questions:

- Are surgeons aware of ergonomic guidelines?
- Do surgeons have access to appropriate facilities, Such as operating room table with adjustable height or access to stool with adjustable height, to apply those guidelines to their work place?
- Do they apply appropriate ergonomic guidelines regarding the surgical procedure that they perform?

1.5. Objectives

A comprehensive question pool including questions that have been used in these popular subjective tools can help researchers to efficiently select questions to create their tools based on their research goals/interests. The first objective of this study is to create one comprehensive question pool by collecting questions from the popular tools that have been used to assess the associations between the risk factors and WMSDs among surgeons and adding self-developed questions regarding the WMSDs risk factors that have received less attention, such as ergonomic guidelines awareness. This can help the researchers interested in this area to create appropriate survey based on their goals of research more efficiently. The second objective of this

study is to use the developed comprehensive question pool to design a new questionnaire and investigate the potential risk factors of developing WMSDs among surgeons with different background and experience.

2. CHAPTER 2: COMPREHENSIVE QUESTION POOL DEVELOPMENT (METHODS)

In order to develop a comprehensive question pool to help the investigators to create their own tool, following steps were followed as demonstrated in Figure 2.

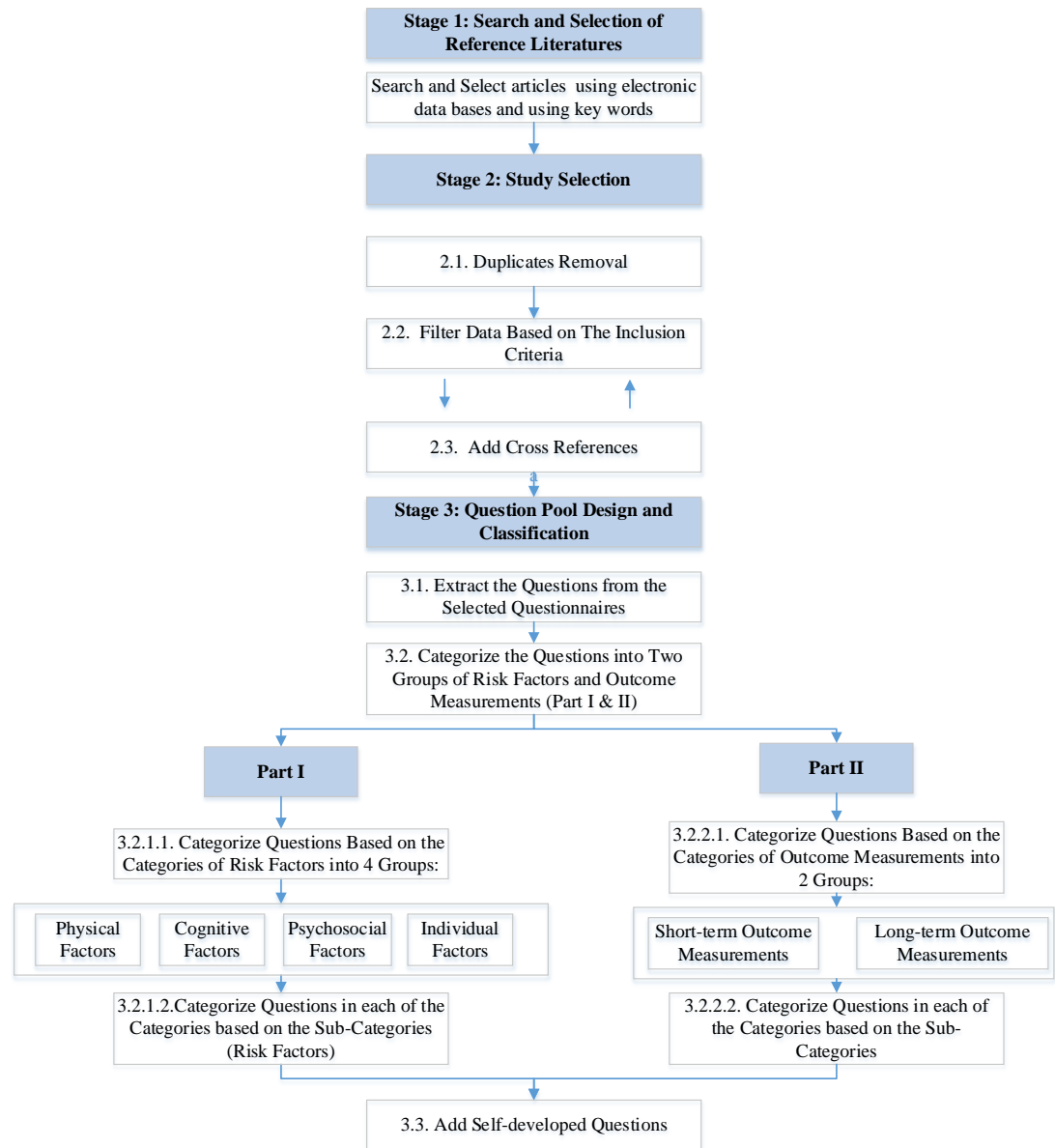


Figure 2 Comprehensive Question Pool Design Steps

2.1. Stage 1: Search and selection of reference literature

2.1.1. Information sources

Electronic databases, such as PubMed, Medline, Web of Science, Science Direct, and Google Scholar were used for article collection. Articles were exported to Zotero reference management tool.

2.1.2. Search

Articles were collected using “workload”, “musculoskeletal disorders”, “posture”, “ergonomic guideline”, “awareness”, “questionnaire”, “survey”, “subjective tool”, “surgeon”, “general surgeon”, “pediatric”, “orthopedic”, “laparoscopic”, “robotic” as keywords in mentioned electronic databases. Various combinations of key words were used as search queries, such as “discomfort AND (survey OR questionnaire)”.

“Musculoskeletal disorders” was chosen because of the fact that the main objective of this paper was to create a comprehensive question pool regarding prevalence of WMSDs. Key words “workload” and “posture” were chosen to find papers specifically regarding those contributing factors to complete the question pool. “Questionnaire”, “survey”, and “subjective tool” were chosen because one of the goals of this study is to create a comprehensive question pool based on existing popular subjective assessment tools, including surveys and questionnaires. “Surgeon” was another keyword due to the fact that the focus of the study was on surgeons among all of the other occupations. Three keywords of “general surgeon”, “pediatric”, and “orthopedic” were selected to have a closer look to the papers association to these specialties. “Ergonomic guideline” and “awareness” were used to find relevant

literature regarding ergonomic guidelines and awareness of ergonomic guidelines among them.

“Laparoscopic” and “robotic” words were used to look for papers targeting surgeons performing three types of conventional open surgery, laparoscopic, and robotic surgery. Performing different surgical procedures require surgeons to use different instruments, equipment, and techniques. In a previous study it has been shown that surgeons performing open surgery experience more physical stress in comparison to laparoscopic surgeries measuring surgeons’ muscle activities (G. P. Y. Szeto et al., 2010). The results of another study indicates that surgeons performing laparoscopic surgeries suffer musculoskeletal injuries more than those who are performing open surgery (A. Park et al., 2010). It has also been shown that robotic and laparoscopic surgery can impose different degree of workload on surgeons (Hubert et al., 2013b). Therefore, developing a comprehensive question pool containing questions regarding these types of surgery can provide useful means for the researchers to compare these surgical procedures. In addition, since performing these surgical procedures requires following different ergonomic guidelines, creating a question pool including questions about different surgical procedures can help the investigators to study whether the surgeons apply appropriate ergonomic guideline based on the surgical procedures that they perform.

2.2. Stage 2: Study selection

2.2.1. Step 2.1: Duplicates removal

Duplicates articles were removed using Zotero reference management. A total of 60 articles were located after duplicate removal.

2.2.2. Step 2.2: Filtering data based on the inclusion criteria

After removing the duplicate items and reviewing the abstracts, full articles were examined to find papers to create a comprehensive question pool based on the following inclusion criteria: (1) using questionnaires/surveys as data collection methods, (2) focusing on surgeons' discomfort, WMSDs and/or their awareness of ergonomic guidelines, (3) providing detailed questions. I screened the collected articles first by their titles and abstracts to check if they meet inclusion criteria. Then, electronic format of full text articles was located and screened for further investigation.

2.2.3. Step 2.3: Adding cross-references

Reference list of known papers were scanned and extra articles were collected if they met mentioned inclusion criteria. In addition, if the modified version of a questionnaire was used, the paper including original format of questionnaire was added to article collection.

2.3. Stage 3: Question pool design and question classification

2.3.1. Step 3.1: Extracting the questions from the selected questionnaires

The questions of the questionnaires that have been use in the selected studies have been extracted.

2.3.2. Step 3.2: Categorizing the questions into two groups of risk factors and outcome measurements (part I & II)

The questions were groups into two main parts. Part I listed the questions regarding the risk factors of developing WMSDs. Part II listed the questions addressing the outcome measurements.

2.3.2.1. Part I: Risk factors

2.3.2.1.1. Step 3.2.1.1: Categorizing questions based on the categories of risk factors into four groups

Questions addressing risk factors in the selected studies were categorized into four main groups of risk factors associated with developing WMSDs: (1) Physical factors, (2) Cognitive factors, (3) Psychosocial factors, and (4) Individual factors.

2.3.2.1.2. Step 3.2.1.2: Categorizing questions in each of the categories based on the risk factors

After classifying the questions based on the categories of risk factors, each of the questions were labeled based on the risk factors. Table 1 demonstrates the most cited risk factors categorized into four main groups of risk factors.

Table 1 Categories of Risk Factors

Physical factors	Cognitive factors	Psychosocial factors	Individual factors
Workstation configuration	Memory demand	Time pressure	Body mass index
Posture	Mapping demand	Job control	Experience
Repetitive Motion	Reasoning demand	Social support	Health condition
Force	Cognitive task difficulty	Work schedule	General demographic characteristics
Vibration	Cognitive workload	Psychological stress	
Temperature		Ergonomics guidelines awareness	
Physical workload		Sense of community	
Instruments manipulation			

2.3.2.2. Part II: Outcome measurements

2.3.2.2.1. Step 3.2.2.1: Categorizing questions based on the categories of outcome measurements into two groups

In addition to the four categories of risk factors, questions addressing outcome measurements were categorized into two categories of short-term and long-term outcome measurements. Questions about the discomfort, stiffness, pain, numbness, and fatigue were categorized as short-term outcome measurements and questions addressing experience of musculoskeletal disorders and disability were categorized as long-term outcome measurements. Table 2 displays the categories of outcome measurements and the factors relating to that.

Table 2 Outcome Measurements Categories

Short-term Outcome Measurements	Long-term Outcome Measurements
Discomfort	Musculoskeletal disorder
Stiffness	Disability
Pain	
Numbness	
Fatigue	

2.3.2.2.2. Step 3.2.2.2: Categorizing questions in each of the categories based on the sub-categories

Each of the questions in the long-term outcome measurements categories were labeled as musculoskeletal disorder and disability based on the content of the questions. Due to the point that most of the questions in short-term outcome measurements addressed all of their sub-categories simultaneously, they were all labeled as short-term outcome measurements.

2.3.3. Step 3.3: Adding self-developed questions

In this step, based on the observed gaps between the questions in the popular existing tools and the cited risk factors associated with the development of WMSDs, new questions were added to the question pool. Most of the developed questions were related to the awareness of ergonomic guidelines, since it was address only in three out of 33 existing tools that have been used to investigate risk factors associated with developing WMSDs.

One of the challenging part of designing the questions was developing questions for investigating the workstation configuration and investigating if the surgeons set the items in the operating rooms based on the ergonomic guidelines. It was challenging because: 1) The appropriate settings depend on a variety of variables, such as individuals' anthropometric characteristics and the surgical techniques that they perform 2) Many of the published ergonomic guidelines reported the settings in terms of numbers, such as distance from floor. It is difficult to ask the participants of the surveys to describe their workstation settings with this precision. In order to fix these problems, questions and the options of the questions were designed asking the surgeons to describe the workstation settings referring to their body. For example, in order to investigate the table height the participants will be ask whether the operating table is located below upper thighs, between thigh and hip, between hip and elbow or above the elbow.

In order to design the questions regarding the ergonomic guidelines, first exiting questions addressing this issue were extracted from the existing subjective tool. Then, developed ergonomic guidelines relating to operating room settings, surgeons'

posture, and instruments manipulation were reviewed to design new questions. In addition, general workstation ergonomic guidelines were used and modified to design new questions addressing surgeons' awareness and implementation of ergonomic guidelines. For example, based on the general ergonomic guidelines, the height of the table should not be too high to enforce the workers to elevate their shoulders and increase the risk of fatigue and MSDs. On the other hand, the table height should not be too low to force the workers bend their shoulder to reach the surface area. In order to achieve that, best table height of 2.5 cm below the elbow has been suggested (Das & Sengupta, 1996).

Based on the type of surgical procedure and the surgical task that the surgeons perform, location of the patients' body part under surgery, and the surgical tools, surgeons required to hold different postures. For example, surgeons may sit on the surgical console or keep standing posture while performing open or laparoscopic surgeries. In addition, performing laparoscopic surgeries requires surgeons to use longer instruments. Therefore, keeping the table height at elbow height may impose physical stress on surgeons. In a study on optimal table height for laparoscopic surgery, it has been shown that holding the instruments around the elbow height and closed to surgeons' body can decrease the perceived discomfort and muscle activities in deltoid and trapezius muscle (Berquer et al., 2002). Due to the variation among surgeons' anthropometrics characteristics and the surgical procedures, having access to the adjustable table or seating stool can help the surgeons to adjust the settings due to ergonomic guidelines. In conclusion, in addition to general ergonomic guidelines regarding height of working surface, there is a need to investigate the literature about

ergonomic guidelines regarding surgery and operating room to develop more valid questions to investigate the operating room settings and the level of ergonomic guideline awareness.

In order to satisfy this need, the papers regarding optimal ergonomic guidelines of performing surgery were reviewed and questions were developed to ask surgeons if they are aware the appropriate table height, if the organization that they work in has provided appropriate means for them to set the table height based on ergonomic guidelines, and finally if they adjust the table height based on the guidelines. The answers to these questions can help the investigators to evaluate the awareness of the ergonomic guidelines and their application among surgeons. In addition, the answers to these questions can help the investigator to assess the association between the ergonomic guideline awareness and the prevalence of discomfort and WMSDs among surgeons.

2.4. Results

A total of 60 subjective assessment tools were identified. As you can see in Table 3, the subjective tools were categorized in three main groups based on their development methods: standard questionnaire, modified questionnaire, and self-developed questionnaires. Standard questionnaires are valid questionnaires that have been used to assess risk factors associated with WMSDs among people with variety of occupations, as well as surgeons. NASA-TLX is an example of standard questionnaire, which has questions regarding cognitive, physical, and psychosocial factors (Hart, 2006). Modified Questionnaires are whether the short version of the standard questionnaire or the versions of questionnaire that have been modified and customized

to answer questions specifically relating to the surgeons' occupations and safety. SURG-TLX is an example of modified questionnaire. Three dimensions of performance, effort, and frustration have been replaced by distraction, situational stress, and task complexity in SURG-TLX to be assess surgeons' workload specifically (Wilson et al., 2011). Self-developed is another category of the questionnaire. Self-developed questionnaires are those that have been designed by the researchers themselves to help them answer their own research questions. The numbers in *Table 3* indicate the number of the papers that have used those tools to investigate the risk factors associated with WMSDs development among surgeons. Questionnaires are categorized into three groups based on their development methods.

Table 3 Numbers of Studies Adopted Each Questionnaire to Investigate WMSDs among Surgeons

No.	Tools	Assessment tools categories		
		standard	Modified version	Self-developed
1	Task Load Index (NASA-TLX)	7		
2	Surgery Task Load Index (SURG-TLX)		3	
3	Nordic Musculoskeletal	6		
4	Extended Version of Standardized Nordic Musculoskeletal (NMQ-E)		1	
5	Body Part Discomfort (BPD)	4		
6	Local Experienced Discomfort (LED)	3		
7	Workstyle Short Form Measure		2	
8	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics	4		
9	Shortened Disabilities of the Arm, Shoulder and Hand (Quick DASH)		1	
10	Subjective Mental Effort Questionnaire (SMEQ)	3		
11	Physical Discomfort	3		
12	University of Michigan Upper Extremity Questionnaire	2		
13	Michigan Hand Outcomes Questionnaire (MHQ)	1		
14	Oswestry Disability	1		
15	12-item General Health Questionnaire (GHQ-12)		1	
*	Self-developed questionnaires			18
	Total number of tools	34	8	18

Among 60 articles which met the inclusion criteria, 10 standard, 5 modified version, and 18 self-developed tools were recognized. The NASA-TLX and Nordic Musculoskeletal questionnaires were the most popular tools.

Table 4 summarizes basic information regarding these subjective tools and the categories of risk factors or outcome measurements that those subjective tools investigate. As you can see in this table, almost half of the tools include questions regarding the physical and individual risk factors. Psychosocial and cognitive risk factors were investigated in 30% and 21% of them, respectively. It was also found that investigating the short-term outcome measurements, such as discomfort, got more attention comparing the long-term outcome measurements.

Table 4 Existing Subjective Assessment Tools and the Risk Factors and Outcome Measurements Categories Investigated

[illegible]

A brief description of each of the existing subjective assessment tools, the risk factors and outcome measurements investigated in those tools, and the studies that have used them have been provided as following:

- **No. 1: Task Load Index (NASA-TLX)** tool asks questions regarding cognitive, physical , and psychosocial factors (Hart, 2006). This tool has been used to assess surgeons' subjective experiences of workload (Carswell, Clarke, & Seales, 2005; Hubert et al., 2013a; Koca et al., 2015; Stefanidis, Wang, Korndorffer, Dunne, & Scott, 2009; Tarr et al., 2015, 2015; Youssef et al., 2011).
- **No.2: The Surgery Task Load Index (SURG-TLX)** is modified version of NASA-TLX that has been designed to assess surgeon's workload specifically (Wilson et al., 2011).
- **No.3: Nordic Musculoskeletal** questionnaire is another subjective tool that has been used to analyze musculoskeletal symptoms asking questions about experience of musculoskeletal trouble in nine parts of body, in addition to individual and psychosocial risk factors (Kuorinka et al., 1987a).
- **No.4: Extended Version of Standardized Nordic Musculoskeletal** questionnaire mainly focus on questions concerning psychosocial factors and posture as one of the physical risk factors. It has been used to assess workload and musculoskeletal trouble among healthcare workers, including surgeons (Roja et al., 2015a).
- **No.5: Body part discomfort questionnaire (BPD)** is a tool using for studying of discomfort as one of the short-term outcome measurements by asking about the location and density of musculoskeletal discomforts in various joints and muscles on a five point scale (Corlett & Bishop, 1976). The BPD questionnaire has been used to assess

laparoscopic and robotic surgeons' discomfort during surgery (Lawson, Curet, Sanchez, Schuster, & Berguer, 2007; Lawson et al., 2007; Tarr et al., 2015).

- **No.6: Local Experienced Discomfort (LED)** is similar to BPD and investigates physical discomfort on a ten-point scale. LED has been used to evaluate the impact of performing different surgical techniques on surgeons' discomfort level (Lopez-Cano et al., 2012; Olivier, Hullenaar, Ruurda, & Broeders, 2008; Reddy et al., 2011)
- **No.7: Workstyle Short Form Measure** has been used to evaluate dermatologic surgeons' psychosocial and behavioral responses regarding to their high demanding jobs and the association of these factors with musculoskeletal discomfort (Liang, Levine, Dusza, Hale, & Nehal, 2012). Workstyle Short Form questionnaire investigated short-term outcome measurements, such as pain, in addition to psychosocial factors of work to evaluate the association between these two factors (Feuerstein & Nicholas, 2006).
- **No.8: SAGES Ergonomics** questionnaire is another tool developed by Society of American Gastrointestinal and Endoscopic Surgeons with aim of describing the problems, such as pain and visual problems while performing surgery and their relation to WMSDs among surgeons (Berguer, 2014; Manukyan et al., 2007).
- **No.9: Quick DASH** is a shortened version of DASH (The disabilities of the arm, shoulder and hand) questionnaire. DASH is a 30-item disabilities questionnaire asking questions regarding the symptom and ability of performing certain tasks (Gummesson, Atroshi, & Ekdahl, 2003). As mentioned, QuickDASH is shortened version of DASH questionnaire focusing on 11 items (Gummesson, Ward, & Atroshi, 2006). In a survey-based study among hand and plastic surgeons disability score were collected using Quick

DASH, in addition to collecting information regarding their musculoskeletal injuries (Capone, Parikh, Gatti, Davidson, & Davison, 2010).

- **No. 10: Subjective Mental Effort Questionnaire (SMEQ)** is another tool that has been used for studying the risks associated with WMSDs among surgeons. It is a tool that let the individuals to rate the amount of cognitive workload during performing task from 0 to 150 points. SMEQ has 9 scale markers corresponding to statements “no effort at all” to “exceptional amount of effort” (Houwing, Wiethoff, Arnold, & Vos, 1993). This tool has been used to assess the cognitive stress of surgeons (Lopez-Cano et al., 2012; Olivier et al., 2008; Reddy et al., 2011).
- **No. 11: Physical Discomfort Survey** is used to assess the location and the severity of pain or discomfort as two of the short-terms outcome measurements of WMSDs. This questionnaire uses a body map demonstrating 14 parts of body, neck, shoulders, elbows, forearm, hand/wrist, upper back, lower back, hip, thigh, knee, lower leg, and ankle/ foot, so subjects can select a level of discomfort/ pain and the frequency of it. This survey has been used to assess the discomfort and pain of orthopedic trauma, spine, laparoscopic, and orthopedic pediatric surgeons (AlQahtani, Alzahrani, & Harvey, 2016; Alqahtani, Alzahrani, & Tanzer, 2016; Alzahrani, Alqahtani, Tanzer, & Hamdy, 2016; Auerbach, Weidner, Milby, Diab, & Lonner, 2011).
- **No.12 & 13: University of Michigan Upper Extremity Outcome and Michigan Hand Outcomes Questionnaire (MHQ)** are also two tools that mainly have been developed to assess patients’ health status after surgery by asking questions regarding factors, such as hand function and pain (Kevin C. Chung, Pillsbury, Walters, & Hayward, 1998; Salerno, Franzblau, Armstrong, Werner, & Becker, 2001). These questionnaires can be

used to assess pain and disability level among the surgeon as they were used in a pilot study among spine surgeons to investigate the risk factors of developing Carpal Tunnel Syndrome (CTP) among them (Forst, Friedman, & Shapiro, 2006).

- **No.14:** The **Oswestry Disability Questionnaire** is a tool that has been designed to evaluate the effect of back pain in patients' daily lives (Fairbank & Pynsent, 2000). Due to the high prevalence of low back pain among healthcare workers, this tool has been used to evaluate low back pain among them including general surgeons. (Mohseni-Bandpei et al., 2011)
- **No. 15:** The **12-item General Health Questionnaire (GHQ-12)** is a modified version of 60-items General Health Questionnaire that contains 12 questions asking questions regarding psychosocial risk factors and experiencing certain behavior (Goldberg et al., 1997). This tool has been used in a study among general surgeons (Mohseni-Bandpei et al., 2011).

In addition to the surveys that have been specifically used for studying the risk factors associated with WMSDs among surgeons, some questionnaires contain questions that can be used to assess surgeons' WMSDs and related risk factors. For example, **Safety Attitudes Questionnaire (SAQ)** is a questionnaire that has been designed to evaluate health care provider attitude toward patient safety by asking questions regarding six main factors of teamwork climate, safety climate, perceptions of, management, job satisfaction, working conditions, and stress recognition (Sexton et al., 2006). Based on the definition of the psychosocial risk factors, these factors can be considered as psychosocial factors and I can use the modified version of the questions of SAQ to assess the risk factors among surgeons. **Cornell Musculoskeletal Discomfort Questionnaires (CMDQ)** is another

questionnaire which includes questions regarding the prevalence of musculoskeletal ache, pain or discomfort in 18 regions of the body (Hedge, Morimoto, & Mccrobie, 1999).

2.5. Comprehensive question pool

The comprehensive question pool was developed following the steps mentioned in the sections 2.1 to 2.3. This comprehensive question pool can help the researchers to have access to the questions that have been used in existing standard, modified, and self-developed tools. As mentioned before, the developed comprehensive question pool consists of two parts: I) questions regarding risk factors and II) questions regarding outcome measurements. Part I includes the questions that have been used for the investigation of the level of risk factors among surgeons and part II lists the questions that have been used to investigate the outcome measurements, including the symptoms and existence of WMSDs. Part I and Part II are described in more detailed in 2.5.1 and 2.5.2. The comprehensive list of questions are provided in appendix 1.

2.5.1. Part I: Risk factors

In the first part of the developed question pool, focus is on questions regarding risk factors. This question pool provides information in four main columns, tool, category of risk factors, risk factor, and question. Table 5 illustrates short section of the question pool part I. As you can see there are four main columns in this question pool described as follows:

1. **Tool:** In this column, the names of the standard and modified version of the standard tools are listed. In addition, the titles of the papers are listed in the same column for the self-developed tools that did not have specific titles for the questionnaires that have been used in those papers.

2. **Category of risk factor:** This column indicates the category of the risk factors that each of the questions of the pools investigate. As mentioned in the 1.2 sections, the risk factors have been categorized into four main groups of physical, cognitive, psychosocial, and individual risk factors, and this column indicates these four main categories.
3. **Risk factor:** In this column, more detailed information regarding the risk factors investigated using the questions is provided. As it was shown in Table 1, each of the categories of risk factors includes information about the risk factors. For example, factors, such as workstation configuration and posture, are considered as physical risk factors.
4. **Question:** All of the questions included in the pool are listed in this column. For each question, the users can find the risk factors investigated using this question, the category of this risk factor, and the tool in which this question has been used. For Example as you can see in Table 5, “Have you experienced any of the following problems during or following laparoscopic surgery? Reverse image when on opposite side of table” is one of the questions in SAGES Ergonomics Questionnaire and investigate workstation configuration as one of the physical risk factor.

Table 5 Comprehensive Question Pool Part I: Risk Factors

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 1	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Physical factors	Workstation configuration	Have you experienced any of the following problems during or following laparoscopic surgery? Reverse image when on opposite side of table
Q 2	NASA-TLX	Cognitive factors	Cognitive workload	How mentally demanding was the task?
Q 3	Workstyle Short Form	Psychosocial Factors	Time pressure	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I have too many deadlines and will never be able to get all my work done.
Q 4	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Individual factors	Experience	How many years and months have you been doing your present type of work?

2.5.2. Part II: Outcome measurements

The second part of the question pool consists of questions regarding outcome measurements. The developed comprehensive question pool as shown in Table 6 provides information in three main columns of tool, category of outcome measurement, and question.

1. **Tool:** Similar to part I, in this column the names of the standard and modified version of the standard tools are listed. In addition, the titles of the papers are listed for the self-developed tools.

2. **Outcome measurement categories:** The outcome measurement have been categorized into two main groups of short-term outcome measurements (e.g., discomfort and stiffness) and long-term outcome measurements (e.g., MSDs and discomfort).
3. **Question:** This column provides the questions, similar to the question column in Part I.

Table 6 Comprehensive Question Pool Part II: Outcome measurements

Question No.	Tool	Outcome Measurement Categories	Question
Q 1	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Short-term outcome measurements	Have you at any time during the last 12 month had trouble (ache, pain, discomfort, numbness) in: 9 body parts including, neck, shoulder, lower back upper and lower body parts
Q 2	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Long-term Outcome measurements	What is the total length of the trouble that you have had the trouble during the last 12 months?

2.5.3. Guidelines for using comprehensive question pool

Researchers can use this question pool in various ways to extract information based on their goal of research:

1. If the researchers are looking for a standard tool for their research, they can observe the standard questionnaires that have been used and the risk factors that they investigate. For example, if researchers are interested in using standard tools to investigate the physical risk factors, they can see the list of the standard

questionnaires for this goal. In this case, NASA-TLX and NMQ-E are examples of the tools that can be used for this purpose.

2. If the researchers are looking for questions to evaluate specific categories of risk factors or outcome measurements, they can choose the appropriate questions using the information in category and subcategory of risk factors. For example, if a researcher is interested in the effects of the physical risk factors on perceived discomfort, he/she can find the questions in the categories of physical risk factor in the Part I and short-term outcomes in Part II.
3. If the researchers are looking for the potential factors that can be influential in developing WMSDs, this question pool can provide information regarding the potential risk factors that can put the surgeons at risk of developing WMSDs and the tools and the questions that can be used to investigate those risk factors. These information is provided in Part I of the comprehensive questionnaire. Researchers can search through the columns category of risk factor and risk factor to find the risk factors that have been investigated in the previous studies.

Overall, the developed comprehensive question pool can help the researchers to choose appropriate tools or create their own tools based on their interests of research and domain of the investigation.

2.6. Discussion

People are at risk of developing WMSDs due to four main sources of risk factors: physical, cognitive, psychosocial, and individual risk factors. Physical risk factors are factors, such as posture and workstation configuration, that can increase the risk of the developing WMSDs. Level of task difficulty is an example of cognitive risk factors. Psychosocial factors (e.g., job control and time pressure) and individual factors (e.g., age and experience) can be influential in the development of WMSDs as well. Surgeons can be exposed to these risk factors due to their demanding job. Researchers have used a variety of tools to investigate the risk factors and prevalence of WMSDs among surgeons based on these research interests. For example, Szeto et al. studied the association between physical and psychosocial risk factors and prevalence of WMSDs among surgeons (Grace P. Y. Szeto et al., 2009).

To help the investigators to use the appropriate tool or design their own tool more efficiently, a comprehensive question pool was developed in this section. In order to develop the question pool, literature review was performed and 33 questionnaires were identified. After categorizing the questions of these 33 tools based on the risk factors, I can see that four groups of risk factors got different levels of attention in the identified tools. Physical and individual factors received more attention than cognitive and psychosocial factors. There are a few possible reasons for that: 1) physical risk factors are more accessible to be investigated than other risk factors using the subjective tools; 2) in many cases it is easier to fix the problems caused by the physical factors in comparison to the cognitive factors. For example, it is easier to provide OR table with adjustable height and adjust it to the an appropriate height to reduce the physical risk factor in comparison to

reducing cognitive workload regarding the complexity of performing surgical procedure;

3) Among all of the occupational risk factors, physical risk factors have been investigated more than the others and have been found to be associated with developing WMSDs in variety of the studies (Malchaire, Cock, & Vergracht, 2001b).

After investigation of the popular existing tools, I also saw that only few of the tools have considered all of the risk factors. Most of the studies only focused on limited categories of risk factors. Therefore, it is impossible to investigate the relationship between factors and only limited number of the studies reported correlation between risk factors.

I also can see that previous studies are mostly focused on studying the short-term effects of performing surgical tasks on the surgeons, like experience of the pain and stiffness due to their job. Fewer studies asked questions to investigate the symptoms of disability and musculoskeletal disorders. This can be due to the fact that the assessment of the long term outcome measurements is more difficult and requires longitudinal studies. This is also because when people self-report the existence of WMSDs, it is difficult to ensure that the characteristics of work design was the contributing factor to the development of reported WMSDs or disability.

This information can help the researchers to identify which risk factors has received less attention. Therefore, it can help the researchers with conducting new research studies to fill the gaps.

Among the psychosocial factors, ergonomic guidelines awareness got the least attention in the previous tools. In the most of the previous studies, the questions were just aimed to ask if the surgeons are aware of the ergonomic guidelines or not. However, it is

also important to ask the surgeons if they know the correct guidelines, if they have means (e.g. adjustable ergonomic stool) to follow the guidelines, and if they apply the guidelines to their job. There is a need to pay more attention to this group of risk factors, as it has been shown that surgeons find ergonomic guidelines very helpful in reducing the physical discomfort (Wauben et al., 2006). Considering this research gap, I added new questions to the question pool using general workplace guidelines and published ergonomic guidelines for operating room. Performing different types of surgical procedures, such as robotic vs. open surgeries, requires surgeons to follow different ergonomic guidelines due to the different layouts of OR, required instruments and tasks. The researchers need to consider their target surgeon population and type of performed surgeries while developing their subject tool.

One of the challenging parts of developing the question pool was categorizing the questions. Categorizing the questions in some cases is highly dependent on the perspective of the researcher and their definition of the risk factors, which were vague or even not provided by the authors on many cases. For example, asking about the types of the surgical procedures that the surgeons have performed can be considered as a question regarding experience as one of the individual risk factors. However, another researcher may consider this question as one of the questions regarding cognitive workload since performing different surgical procedures can have different degrees of complexity and cognitive workload.

The developed comprehensive question pool is useful since it can help the researchers to: 1) Get familiar with the popular existing tools in the assessment of the WMSDs among surgeons and the risk factors that they investigate; 2) Select questionnaire

based on the risk factors and outcome measurements of interest; 3) Select questions based on the risk factors of interest to create a self-developed tool; 4) Identify potential risk factors in developing WMSDs among surgeons; 5) Identify gap in previous study. Developing this question pool is also can be helpful because it contains information about the subjective tools, which are very valuable as they can be used to collect information regarding the level of risk and perceived discomfort without facing difficulties, such as setting up the data collection equipment at limited space of operating room.

This paper can help the researchers to identify the potential risk factors regarding the development of WMSDs among surgeons. In addition, they can observe the level of attention to each of the risk factors in previous studies to examine the gap in previous investigations. This paper can guide the investigators to use suitable tools based on their goal of study more efficiently.

Since most of the risk factors are not only limited to surgeons' work environment, researchers who are interested in investigating the risk factors associated with WMSDs among other occupations can use this paper to evaluate the risk factors and then design ergonomic interventions to improve the work environment. On the other hand, further investigation of the subjective tools that have been used to assess WMSDs among other occupations can help in improving the question pools.

3. CHAPTER 3: RISK FACTORS ASSOCIATED WITH SURGEONS' WMSDs

3.1. Introduction

WMSDs are major health issues in various occupations (Punnett & Wegman, 2004) . WMSDs in different occupations, such as bus drivers and office workers has been investigated extensively (Gerr et al., 2002; Grace Szeto, 2007). In addition, WMSDs among health professional such as nurses and nurse assistants has been investigated and it has been reported that ten to forty percent of low back pain concerning nurses (Fujishiro, Weaver, Heaney, Hamrick, & Marras, 2005; Roja, Kalkis, & Roja, 2015; Shannon et al., 2001). Relatively few studies have examined WMSDs among surgeons. In one study the healthcare workers' muscles fatigue have been studied, and the results indicate high frequency of complains of feeling discomfort after work among three groups of under study: surgeons, anesthetists, and geneticists (Cavanagh, Brake, Kearns, & Hong, 2012b). The results of conducting survey among surgeons also indicated high prevalence of physical discomfort, especially in neck, back and shoulder of the surgeons (Mirbod et al., 1995; Grace P. Y. Szeto et al., 2009; Wauben, van Veelen, et al., 2006).

Due to the high prevalence of WMSDs among surgeons and the effects of physical, cognitive, individual, and psychosocial factors, including ergonomic guideline awareness on developing WMSDs among surgeons, there is a need to characterize the risk factors among surgeons performing surgery using different surgical techniques and assess their correlation with developing WMSDs thoroughly. In addition, there is a need to study the interaction of the risk factors and investigate the difference between the level of risk factors while performing different surgical techniques and procedures. In order to investigate these associations, I used the comprehensive question pool to choose a list of questions to answer

our question of research. The primary objective of this study is to investigate the risk factors associated with the prevalence of WMSDs among surgeons with diverse backgrounds using a new questionnaire developed based on the comprehensive question pool.

3.2. Hypotheses

The objective of this questionnaire is to test the general hypothesis that different categories of risk factors affect the prevalence of WMSDs among surgeons. In order to test this general hypothesis, following hypotheses will be tested:

- Hypothesis 1: The level of risk factors and prevalence of WMSDs are different among surgeons who perform different techniques of surgeries, open, laparoscopic, and robotic.
- Hypothesis 2: The level of risk factors of developing WMSDs is lower among surgeons who are aware of ergonomic guidelines compared with surgeons without ergonomic guideline awareness.
- Hypothesis 3: The high level of physical, cognitive, psychosocial, and individual risk factor leads to an increase in the prevalence of WMSDs.

In addition to these main hypotheses, I am investigating any potential risk factors associated with WMSDs among surgeons and interactions between the risk factors.

3.3. Methods

3.3.1. Development of the questionnaire

The developed comprehensive question pool (section 2) was used to create a questionnaire to address the questions of study. The general flow of the developed questionnaire is shown in Figure 3. In order to address the questions of study, questions

from four main categories of risk factors, physical, cognitive, psychosocial, and individual were selected using the comprehensive question pool part I. In addition, questions regarding short-term outcome measurement and long-term outcome measurements were chosen from question pool part II. Furthermore, because I wanted to compare the level of these risk factors and prevalence of WMSDs among different techniques of surgeries, questions regarding to three techniques of surgeries, open, laparoscopic, and robotic were whether selected or added as self-development questions. Detailed description of the outline of the questionnaire is described in section 1.1.1 and the full content of the developed questionnaire can be found in appendix 2.

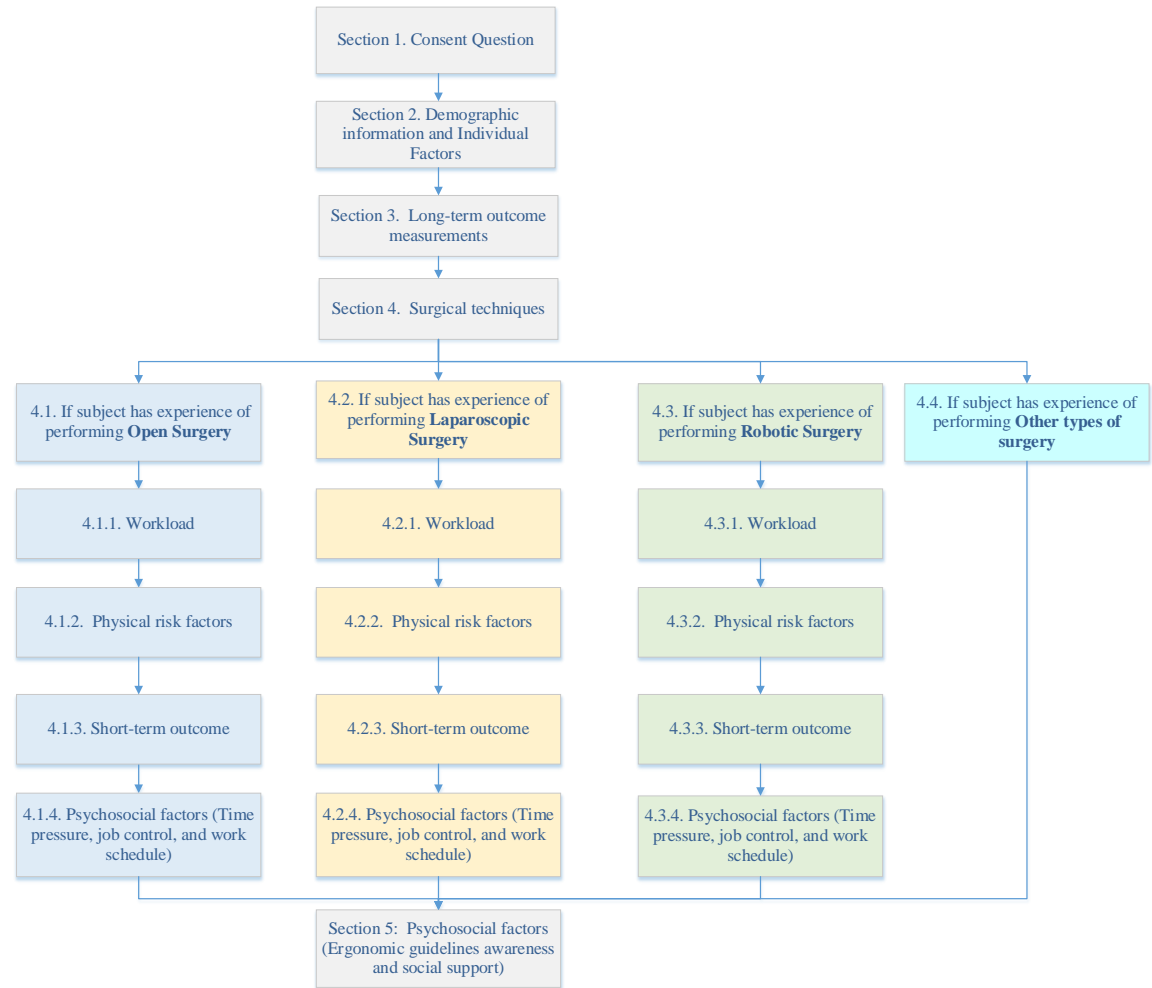


Figure 3 Survey General Flow

3.3.1.1. Section 1: Consent form

In the first question, a brief description of the objectives of the survey was mentioned. In addition, some information regarding the number of questions in the surveys, the anonymity, and contact information was provided. The content of the first question was approved by Oregon State University Institutional Review Board (IRB). At the end of the consent form, the potential participant will be asked if they want to partake in the study. By accepting the conditions, they will be referred to further questions. In addition, it is

mentioned in the consent form that the participating in the questionnaire is voluntary. Therefore, contacted persons can refuse to participate in the survey.

3.3.1.2. Section 2: Demographic information and individual factors

In this section, some questions regarding demographic information and individual factors were selected from the developed question pool. In order to select the questions, part I of the developed comprehensive question pool was used. “Individual risk factor” was selected as the category of the risk factor of the interest. Then, questions regarding gender, weight, height, dominant hand, specialty, practice setting (e.g. community, academic, private, etc.), position (e.g. attending, fellow, resident, etc.) were selected from the question pool part I. In addition, some questions regarding the years of experience, average number of surgeries performed in one typical week and year, average number of days performing surgery in a typical week or working day, and average number of hours for one typical surgery were selected. These questions will help us to get some background information to compare these factors between surgeons, in addition to assess their association with the development of the WMSDs and other risk factors.

3.3.1.3. Section 3: Long-term outcome measurements

In this section, questions regarding the long-term outcome measurements and history of MSDs were selected from the question pool. Questions regarding this factor were selected from part II of the developed questionnaire. Long-term outcome measurements was selected for “Outcome Measurement Categories” column and questions regarding the WMSDs were extracted.

In this section, first the participants will be asked if they have ever been diagnosed with any types of WMSDs. If they answered yes, they will be asked to select the name(s)

of them, including low back pain and wrist tendinitis. Then, they will be asked to answer questions regarding receiving therapy or treatment, being hospitalized, and being forced to change their job because of their MSDs. The questions were designed in a way to make questionnaire as concise as possible. In order to do that, if the surgeons mentioned that they have never been diagnosed with any types of MSDs, questions regarding name of the MSDs and receiving treatment will not be displayed. General flow of the questions in this section has been shown in Figure 4.

Questions regarding receiving treatments are customized based on the type of the MSDs that the surgeons were selected. For example as you can see in Figure 5, subject has indicated history of low back pain and wrist/forearm tendinitis so he will be asked if he has received any types of treatments for any of those MSDs.

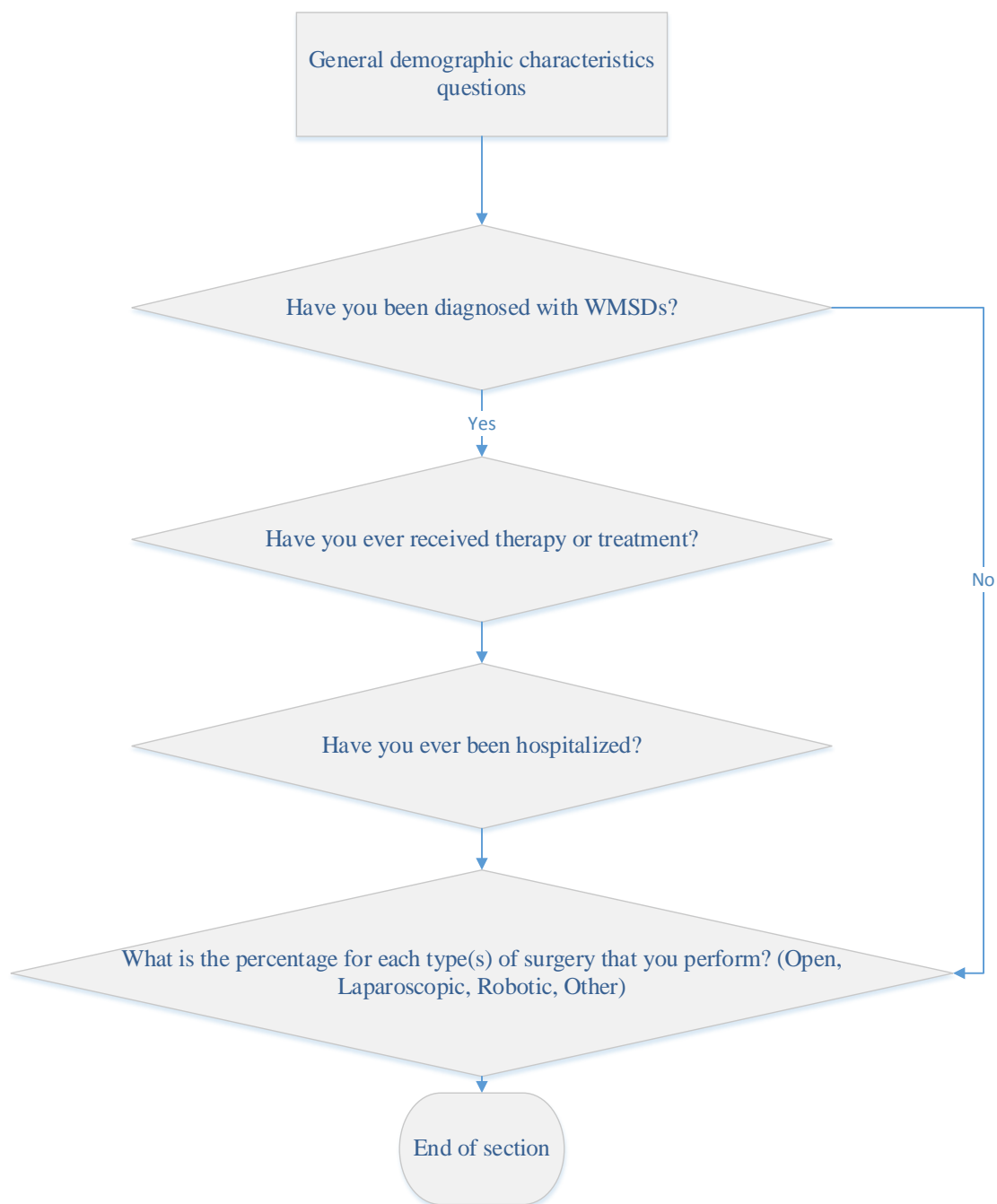


Figure 4 Demographic and Individual risk factors questions outline

Which type(s) of **musculoskeletal disorders** have you been diagnosed that you attribute to your work as a surgeon? (Check all that apply)

- ☒ Low back pain
- ☒ Wrist/forearm tendinitis
- ☐ Wrist/forearm tenosynovitis
- ☐ Lateral epicondylitis
- ☐ Plantar fasciitis
- ☐ CTS (Carpal tunnel syndrome)
- ☐ Shoulder pain (tendinitis)
- ☐ Knee osteoarthritis
- ☐ Tennis Elbow
- ☐ Prolapsed / herniated disc
- ☐ Rotator cuff injury
- ☐ ACL/ meniscus tear / Knee injury
- ☐ Other (please specify):

Have you ever received **therapy or treatment** because of the musculoskeletal disorder ?

	Yes	No	Unsure
Low back pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wrist/forearm tendinitis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Have you ever been **hospitalized** because of the trouble?

	Yes	No	Unsure
Low back pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wrist/forearm tendinitis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Have you ever had to **change your job routine** because of the musculoskeletal disorder?

	Yes	No	Unsure
Low back pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wrist/forearm tendinitis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Survey Completion
0%  100%

Figure 5 Long-term Outcome Measurements Questions Examples

These questions will help us to get some background information regarding history of MSDs to compare these factors between surgeons, in addition to assess their association with the development of WMSDs and other risk factors.

3.3.1.4. Section 4: Surgical techniques

In this section, participants will be asked to select the surgical techniques that they have performed. Surgeons can choose from three conventional techniques of open, laparoscopic, and robotics, or they can select other and specify the name of that technique. In addition to selecting the surgical techniques, participants will be asked to state the percentage for each of the surgical techniques that they perform. Based on the answer of the participants and the surgical techniques that they use, further questions regarding workload, physical risk factors, short-term outcome measurements, and psychosocial risk factors are getting customized. For example, if the subject performs open surgery, the following questions will ask the subjects about the number of the open surgery procedures that he/she performs in one typical year.

The questions regarding three surgical techniques of open, laparoscopic, and robotic were specifically selected because these techniques can impose different types and degrees of stress due to different procedures, instruments, operating room setting and other contributing factors. Applying different ergonomic guidelines are necessary for different surgical techniques as well. Therefore, asking specific questions regarding surgical techniques will provide means for us to compare the effects of any of these techniques on development of WMSDs. Also, it will help us to ask specific questions regarding ergonomic guideline awareness among surgeons. Figure 6 shows the outline of the questions in this section.

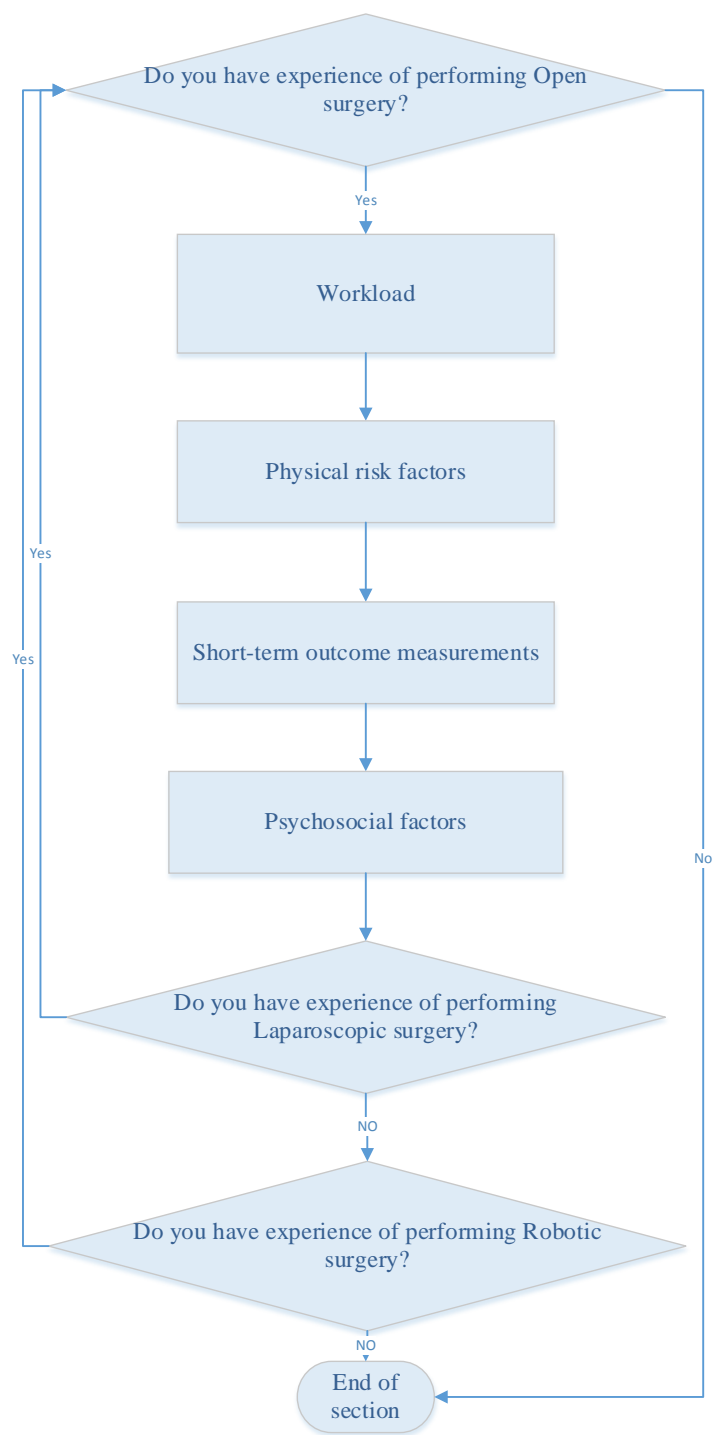


Figure 6 Outline of Questions Regarding Risk Factors for each of Surgical Techniques (Open, Laparoscopic, and Robotic)

3.3.1.4.1. Workload

In sections 4.1.1, 4.2.1, and 4.3.1, surgeons will be asked some questions regarding the workload for each of the surgical techniques that they have selected in section 4. In order to evaluate workload, questions addressing the average number of surgical procedure and number of days of performing surgical procedures were developed.

3.3.1.4.2. Physical risk factors

In sections 4.1.2, 4.2.2 and 4.3.2 of the questionnaire, subjects will be asked questions regarding the workstation configuration, such as access to adjustable table, the height and location of table while performing that specific surgical procedure. In addition, they will answer questions regarding their posture while performing surgical procedures. For example, they will be asked about duration of keeping neck bent while performing surgical procedures or if they have experienced positioning themselves around the operating room table.

The questions concerning workstation configuration are highly related to the ergonomic guideline awareness. In developing these questions, the similar questions from previous studies and self-developed questions regarding ergonomic guidelines based on general ergonomic guideline at work place and ergonomic guideline at operating room. For example, while asking about the height of the table, based on the answer of the subjects I can understand if they adjust the table height based on standard ergonomic guideline or not. The questions have been customized based on the experience of the surgeons with surgical procedure of open, laparoscopic, and robotic. This customization is because of the fact that performing different surgical procedure require following different ergonomic guidelines. For example, based on the ergonomic guideline, the table height should be adjusted slightly

below the elbow height. However, the ergonomic guidelines suggest lower height for operating table. In addition to these questions, some questions have been specifically designed for the assessment of the level of ergonomic guidelines awareness.

In order to develop questions about physical risk factors, part I of the developed question pool was used. “physical risk factors” was selected as the category of the risk factor. Then, based on the risk factors investigated in the previous studies and the risk factors of interest questions were selected from the comprehensive question pool part I. In addition, some questions were selected from “psychosocial risk factor” and “ergonomic guideline awareness” section of comprehensive question pool part I.

These questions will help us to investigate the level of physical risk factors by asking questions about workstation configuration and surgeons’ posture. In addition, I can assess whether the surgeons follow ergonomic guidelines. Furthermore, I can compare the physical risk factor level among different surgical procedures.

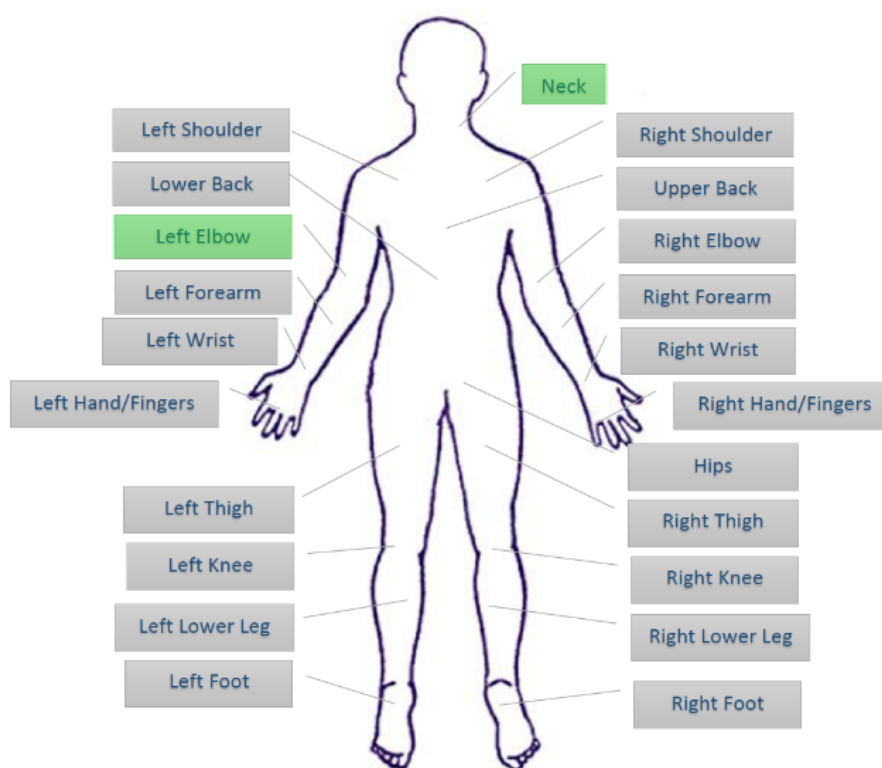
3.3.1.4.3. Short-term outcome measurements

In sections 4.1.3, 4.2.3 and 4.3.3, subjects will be asked if they have experienced any form of discomfort, including pain, stiffness, numbness, or burning sensation, due to performing the specific surgical procedure. If the subjects indicated experience of discomfort, they will be asked to choose the location of the discomfort. A body map has been developed, so subjects can select the specific body part based on their experience. Based on the selected body part(s), they will answer some questions regarding frequency and severity of the discomfort in those body parts. As you can see in Figure 7, for example this subject has selected neck and elbow as location of discomfort, which are shown in green

box. Based on this answer, next question has been modified so they will be asked about the frequency and location of discomfort only in neck and left elbow.

The questions in this section were selected from the developed comprehensive question pool part I and “short-term outcome measurements” were selected as the category of outcome measurements. These questions will us to investigate the location and severity of the discomfort after performing specific surgical procedures.

The following diagram shows the approximate position of body parts. Please Select the **location(s)** of the discomfort after performing open surgery. (Discomfort may include pain, stiffness, numbness or burning sensation)



Please answer questions regarding the **frequency** and **severity** of discomfort after performing open surgery. (Discomfort may include pain, stiffness, numbness or burning sensation)

	How often do you experience discomfort in the selected body part?			How much discomfort do you experience in the selected body part?		
	Occasionally	Often	Always	Occasionally	Often	Always
Neck	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Left elbow	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Occasionally	Often	Always	Occasionally	Often	Always

Figure 7 Example of the Questions Regarding Short-Term Outcome Measurements

3.3.1.4.4. Psychosocial factors part I: Time pressure, job control, and work schedule

In the sections 4.1.4, 4.2.4 and 4.3.4, the first set of questions about psychosocial factors are presented. Subjects will be asked questions regarding time pressure, job control, and work schedule based on their experience with performing various surgical procedures. For example, they will be asked whether they find performing surgical procedures rushed or whether they can communicate with their colleagues.

These questions can help us to investigate the level of psychosocial factors at surgeons' work place and its association with short-term and long-term outcome measurements. In addition, I can compare the level of psychosocial factors between three surgical procedures of open, laparoscopic and robotic.

3.3.1.5. Section 5: Psychosocial factors part II

In the sections 5, the second set of psychosocial factors concerning ergonomic guideline awareness and social support were listed. The questions were selected from the part I of the developed question pool. In order to that, psychosocial factors were selected as the category of the risk factors and appropriate questions were selected.

In this section, subjects will be asked some questions regarding overall ergonomic guideline awareness and receiving social support in their work environment. For example, they will be asked if they are aware of ergonomic guidelines and if they follow those guidelines. If they indicated that they do not apply ergonomic guidelines at work, they will also be asked to indicate the reason for not applying them. Their answers will help us to understand if they do not apply guidelines because they do not have access to suitable tools, such as operating table will adjustable height or they just do not find ergonomic guidelines

helpful. In addition, they will be asked questions regarding support resources that they will receive in case of injury and other factors regarding social support at work place.

3.3.2. Questionnaire interface and software

Online version of the questionnaire and distributing the survey among surgeons were conducted using Qualtrics software (Qualtrics, Provo, UT). Question sections mentioned in previous sections were developed in blocks of questions. At first surgeons were asked questions regarding individual factors and demographic information. After asking questions regarding the types of surgical procedures, conventional, laparoscopic, and robotic, participants will see questions modified based on their surgical experience. In the last block, questions regarding the psychosocial risk factors of job were developed to assess these factors and their contribution to the development of WMSDs. Figure 8 illustrates the interface of the survey and the first question of the questionnaire. As you can see in Figure 8, completion bar has been added to survey to improve usability and rate of respond from the participants.

OSU
Oregon State
UNIVERSITY

The purpose of this study is investigating the risk of developing work-related musculoskeletal disorders (WRMSDs) among surgeons with diverse backgrounds. This study is conducted by a student for the completion for their thesis. You will be asked to fill out a survey which includes questions in the following categories:

- Demographic characteristics
- Work experience
- History of WRMSDs What is your **gender**?
- Risk factors associated with the development of WRMSDs in OR

The data collected in this study will be used to evaluate the associations between risk factors and the prevalence of surgeons' WRMSDs and to assist in developing ergonomic interventions to reduce of the risk of developing of WRMSDs among surgeons.

Your participation in this study is **anonymous** and **voluntary**. The number of questions that you will respond to will vary between **23** and **125** based on your experience in performing surgery. As a way to thank you for your participation, individuals who complete the survey can enter into a random drawing to **win one of five \$100 Amazon gift cards**. If you are interested in participating in the lottery, you will be instructed to submit your contact information after submitting your survey. We will only use the information to contact you if you won the lottery. There will be **no link** between your answers and your contact information.

If you have any questions about this research project, please contact the Principle Investigator Dr. Xinhui Zhu (zhuxin@oregonstate.edu) or Student Researcher Kiana Kia (kiak@oregonstate.edu). If you have questions about your rights or welfare as a participant, please contact the Oregon State University Human Research Protection Program (HRPP) office, at (541) 737-8008 or by email at (IRB@oregonstate.edu).

Are you willing to participate in this study?

☐ Yes

☐ No

Survey Completion
0% 100%

>> Next

Survey Powered By [Qualtrics](#)

Figure 8 Questionnaire Interface in Qualtrics

3.3.3. Distribution and Subjects

After receiving Institutional Review Board (IRB) approval, societies of surgeons, whose members had high rate of respond in previous studies were contacted to get permission of using their email list to distribute the survey. Due to the time limitation, it

was decided to contact surgeons from local hospitals in order to distribute the surveys to them via email. Seven surgeons with experience with variety of surgical procedures were participated in the survey. This pilot study provided valuable information regarding risk factors of developing WMSDs among surgeons and provided an opportunity for us to evaluate the content and user-friendliness of the survey. However, there is a need of distribution among larger group of surgeons with a diverse background in the future.

3.3.4. Data analysis

Once the data collection was completed, the process of data analysis was started. The responses to the questionnaire were exported using the Qualtrics (Qualtrics, Provo, UT). Microsoft Excel (2016) and JMP Pro 12.0.1 (SAS Institute Inc., 2015) were used to categorize the data and measure mean, standard deviation, and other descriptive statistical measurements. Due to the limited number of participants only descriptive data analysis were performed and results are presented in section 3.4.

3.4. Results

3.4.1. General demographic and individual factors information

A total of seven surgeons from local hospitals were participated in the survey. The average (SD) of the experience of the participants was 19.07 (8.13) years and all of them were attending surgeons. Five types of surgeons with different specialties—general, Gynecologist, Orthopedic, Plastic, and Oncologist Surgeons—were participated in the survey. The detailed demographic information of the participants are presented in Table 7.

Table 7 General Demographic and Individual Factor Information of the Surgeons (n=7)

Variables		Categories				
Gender	Male	Female				
	4	3				
Age	31-35	36-40	41-45	46-50	51-55	56-60
	1	1	1	2	1	1
Height (cm)						
Mean (SD)		175.26 (4)				
Weight (pounds)						
Mean (SD)		169.28 (19.66)				
Dominant hand	Right	Left				
	6	1				
Specialty	General Surgeons	Gynecologist	Orthopedic	Plastic Surgeon	Oncologist	
	(n)	2	2	1	1	1
Surgical Procedure Performed	Open	Laparoscopic	Robotic			
	(n)	5	5	2		
Practice setting	Academic	Community				
	(n)	6	1			
Position	Attending					
	(n)	7				
Experience of performing surgery (years)						
Mean (SD)		19.07 (8.13)				

As it is shown in Table 7, each of the surgeons had experience of performing one or more surgical procedures. Five of the subjects had experience of performing open surgery. In addition, five of the surgeons had experience of performing laparoscopic

surgery. Only two of the subjects had experience of performing robotic surgery. One of the subjects had experience of performing arthroscopic surgery, which is one type of minimally invasive surgery similar to laparoscopic surgery. Two of the surgeons stated vaginal surgery as a surgical procedure that they perform. Their work condition can be considered similar to open surgery. Table 8 demonstrates the percentage of the time that each of the participants spend performing each of the surgical procedures investigated in this study.

Table 8 Percentage of Time Performing Each Type(S) Of Surgery

Subject	Surgical procedure				
	Open	Laparoscopic	Robotic	Arthroscopic	vaginal
S1	30%	70%	0%	0%	0%
S2	100%	0%	0%	0%	0%
S3	15%	80%	5%	0%	0%
S4	25%	0%	0%	75%	0%
S5	0%	10%	50%	0%	40%
S6	75%	25%	0%	0%	0%
S7	0%	50%	0%	0%	50%

3.4.2. Work load and experience

Based on the experience of each of the surgeons with performing each types of surgical procedures, the workload level of the subjects are presented in Table 9.

Table 9 Subjects' Workload and Experience by Types of Surgical Procedures

Variables	Surgical procedure		
	Open	Laparoscopic	Robotic
	(n= 5)	(n= 5)	(n= 2)
Experience of performing the surgical procedure, n (SD)	20.7 (11.18)	19.6 (6.46)	8.5 (3.53)
No. of surgeries performed in one typical working week, n (SD)	4.1 (6.1)	3 (2.73)	1.25 (1.06)
No. of surgeries performed in one typical working day, n (SD)	2 (2.8)	1.6 (0.89)	1 (0)
No. of days that the surgeons performed surgery in one typical week, n (SD)	1.5 (0.5)	1.5 (0.7)	1.5 (0.7)
Duration of one typical surgery (hrs), n (SD)	4 (2.73)	3.4 (2.77)	3.25 (1.06)

3.4.3. Physical risk factor

The results of the investigating surgeons' work place in terms of physical risk factors are presented in two main sections. The first section is about the operating room configuration and the second section is about posture of the surgeons.

3.4.3.1. Operating room configuration

The status of operation room configuration in terms of location and the frequency of using equipment, such as operation room table, sitting stool, monitor, arm support and foot pedal were investigated. The result of these investigations for each of the operating room items are presented in the following sections.

3.4.3.1.1. Operating room table/ work surface

All of the investigated surgeons had access to adjustable operating room or work surface and adjust the height of the operating room at least once before every operation. The surgeons with experience of performing open and laparoscopic surgeries stated that they change the height of the operating table to relieve the discomfort caused by performing surgeries. However, none of the robotic surgeons said that they change the height of the work surface to relieve discomfort. The results also indicated that most of the participants adjust the operating table height at a height level between upper thigh and elbow.

Based on the ergonomic guidelines, the working surface should be around 5 cm below elbow height. Since longer instruments are used while performing laparoscopic surgeries, it is recommended to set the table at height lower than open surgery table height. However, one of the surgeons sets the laparoscopic surgery table higher than open surgery and another surgeon sets both of open and laparoscopic surgery table at the same height at hip and elbow height, which is can be high for performing laparoscopic surgeries. The

detailed information regarding the operating room table settings have been listed in Table 10.

Table 10 Operating Room Table/ Work Surface Settings

operating room table/ work surface	Options	Open (n= 5)	Laparoscopic (n= 5)	Robotic (n= 2)	All (n= 12)
No. of surgeons with access to adjustable operating room table/ work surface		5	5	2	12
Frequency of adjusting operating room table	Never	0	0	0	0
	Once before each procedure	1	1	2	4
	Multiple times during one procedure	4	4	0	8
Frequency of adjusting operating room table/ work surface to relieve discomfort	Never	0	0	0	0
	Occasionally	1	0	0	1
	Often	2	2	0	4
	Always	1	3	0	4
Operating room table/ work surface setting	The operating room table is located at height level below my upper thigh	0	1	0	1
	The operating room table is located at height level between my upper thigh and hip	3	1	1	5
	The operating table is located at height level between my hip and elbow	2	3	1	6
	The operating table is located at height level above my elbow	0	0	0	0

3.4.3.1.2. Sitting stool

As it is shown in Table 11, only one of the surgeon with experience of performing open surgery and one surgeon with experience of performing laparoscopic surgery use sitting stool while performing surgical procedure. However, all of the robotic surgeons use sitting stool. The surgical robot usually consists of sitting stool, display, and master controls and requires surgeons to sit during the robotic surgery session. Robotic surgeons

in the study had the lowest rate of discomfort in legs and knees in comparison to the other surgical procedures.

Table 11 Sitting stool settings

Sitting stool	Options	Open (n= 5)	Laparoscopic (n= 5)	Robotic (n= 2)	All (n= 12)
No. of surgeons with access to adjustable sitting stool		1	1	2	4
Frequency of adjusting sitting stool					
	Never	0	0	0	0
	Once before each procedure	1	0	2	3
	Multiple times during one procedure	0	1	0	1
Frequency of adjusting sitting stool table to relieve discomfort					
	Never	0	0	0	0
	Occasionally	0	1	0	1
	Often	0	0	0	0
	Always	0	0	0	0

3.4.3.1.3. Monitor

Monitor in the operating rooms can be used for different reasons. In this study, only one the surgeons stated that he/she does not use monitor for open surgery. Most of the surgeons use the monitor for observing patient vital sign and observing camera view. Most of the participants have access to adjustable monitor and they change the settings of the monitor multiple times during the one surgical procedure.

Most of the ergonomic guidelines suggest the monitor to be located straight ahead of the surgeons and at the height level between the eye and hand level to prevent neck flexion and extension and spine axial rotation (Det, Meijerink, Hoff, Tottf, & Pierie, 2008; Quinn & Moohan, 2015). On a study on preference of location of the monitor while performing laparoscopic surgery and muscle activity in neck, the surgeons stated that they

prefer a monitor in front of them and at eye height and the neck muscle activity was lower while performing laparoscopic surgery with monitor at mentioned location (Matern, Faist, Kehl, Giebmeyer, & Buess, 2005). Most of the participants in this study adjusted the monitor in front of themselves or slightly located to their side. However, two of the surgeons stated that during open and laparoscopic surgeries the monitor is located off to the side, which can result in discomfort in the neck. In term of vertical height, 50 percent of the surgeons stated that the monitors are located above the eye height. This may result in neck extension and discomfort in neck, as it will be presented in section 3.4.5, the participants reposted high rate discomfort at neck. The detailed information regarding the monitor settings of the participants are presented in Table 12.

Table 12 Monitor Settings

Monitor	Options	Open (n= 5)	Laparoscopic (n= 5)	Robotic (n= 2)	All (n= 12)
Time spent using monitor(s)	Never	1	0	0	1
	Occasionally	2	0	1	3
	Often	1	1	1	3
	Always	1	4	0	5
No. of surgeons with access to adjustable monitor		4	5	2	11
Frequency of adjusting monitor	Never	1	0	0	1
	Once before each procedure	0	0	0	0
	Multiple times during one procedure	2	4	1	7
Frequency of adjusting monitor to relieve discomfort	Never	0	0	0	0
	Occasionally	0	1	1	2
	Often	1	2	1	4
	Always	1	1	0	2
Monitor settings:					
	The monitor is located directly in front of me	3	2	1	6
	The monitor is located slightly to the side	2	2	0	4
	The monitor is located off to the side	1	1	0	2
	The monitor is located below hand height	0	0	0	0
	The monitor is located between hand and eye height	1	2	0	3
	The monitor is located above the eye height	2	3	1	6
	The monitor is located far and closed enough to avoid twist in neck/body	2	3	0	5
purpose(s) for using monitor in operating room					
	For observing medical records (surgical images, x-ray images, ...)	0	0	0	0
	For observing patient vital signs	2	2	1	5
	For observing camera view	2	5	2	9
	Others: intraoperative ultrasound	1	0	0	1

3.4.3.1.4. Arm support

Table 13 demonstrates the frequency of using arm support among surgeons. As you can see, surgeons use arm support more often while performing open surgery in comparison to other types of surgical procedures.

Table 13 Arm Support

Arm support	Options	Open (n= 5)	Laparoscopic (n= 5)	Robotic (n= 2)	All (n= 12)
Frequency of using arm support					
	Never	0	4	1	5
	Occasionally	1	0	0	1
	Often	2	1	0	3
	Always	1	0	1	2

3.4.3.1.5. Foot pedal

As it is shown in Table 14, only few participants use foot pedal while performing open and robotic surgeries. However, all of the participants stated they used foot pedal.

Table 14 Foot Pedal

Foot pedal	Options	Open (n= 5)	Laparoscopic (n= 5)	Robotic (n= 2)	All (n= 12)
Frequency of using foot pedal					
	Never	0	0	0	0
	Occasionally	1	2	1	4
	Often	2	0	0	2
	Always	1	3	1	5
No. of surgeons looking down before operating the foot pedal					
		1	2	0	3

3.4.3.2. Posture

The subjects answered to questions regarding their posture while performing surgery. The results indicate that many of the surgeons keep their neck bent or twisted

while performing surgeries. This awkward posture can result in discomfort in the neck. As it is shown in section 3.4.5, most of surgeons feel discomfort in their neck after performing surgery. Based on the results, lifting shoulder, keeping trunk in awkward posture, keeping wrist and fingers twisted and flexed are the forms of awkward posters that subjects stated that they hold while performing surgery. Figure 9 demonstrates the types of awkward postures and percentage of the surgeons that keep those awkward postures while performing each types of surgical procedures. For example, all of the surgeons stated that they hold their neck bent and twisted to left or right after performing open surgery. However, the results indicates that laparoscopic and robotic surgeons hold their neck in awkward posture less often. The full list of the questions addressing twelve awkward posture of the surgeons and the responses of the surgeons are listed in Table 15.

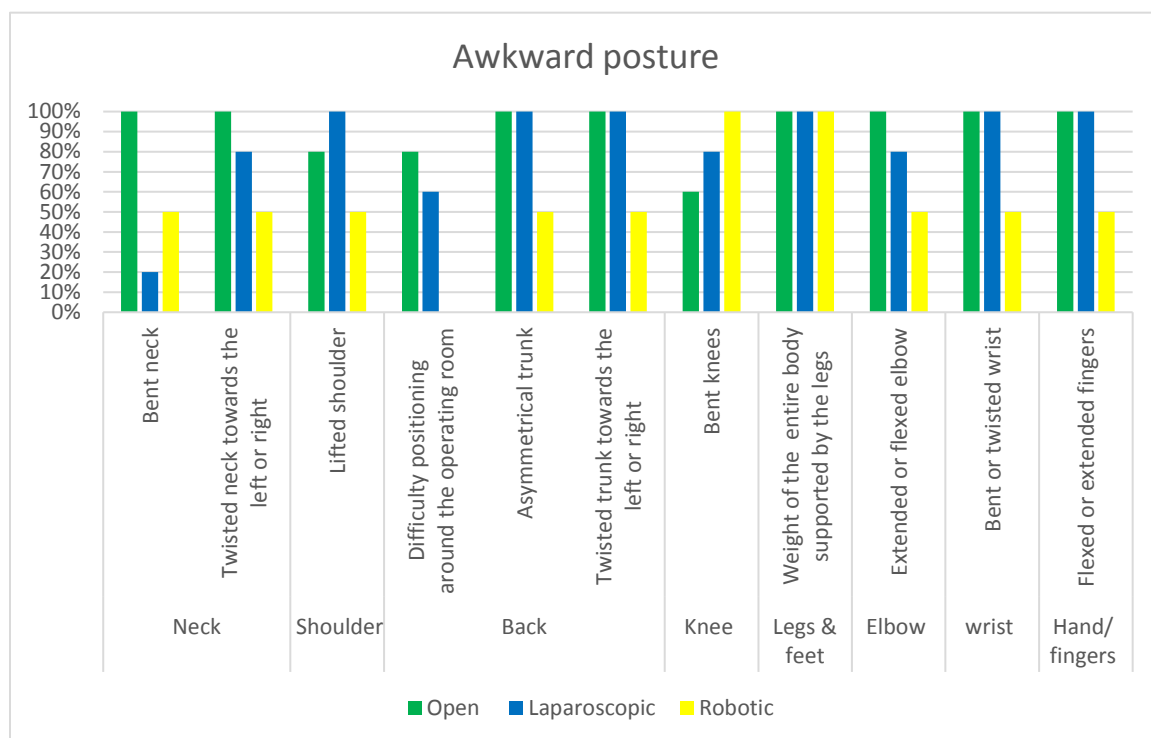


Figure 9 Frequency and Prevalence of Keeping Awkward Posture among Surgeons by Types of Surgical Procedures and Body Regions

Table 15 The Posture of the Surgeons Performing Open, Laparoscopic and Robotic Surgery, n (%)

[illegible]

3.4.4. Psychosocial risk factors

3.4.4.1. Psychosocial factors part I: time pressure, job control, and work schedule

The surgeons responded to the questions regarding the psychosocial risk factors. Table 16 demonstrate the responses of the participants to the questions regarding time pressure, job control, and work schedule. Due to the limited number of participant for each of the surgical techniques of open, laparoscopic and robotic, it is not possible to perform data analysis and compare the risk factors. However, the responses of the participants indicate that surgeons do not feel time pressure while performing surgery and most of them occasionally take time to pause and stretch and have some level of job control. Comparing surgical procedures, performing robotic surgery is more dependent on other colleagues and probably impose less degree of job control to the surgeons. In terms of communication, all of the robotic surgeons stated that they experience communication breakdowns during surgery that lead to delays in surgery. The psychosocial characteristics of participants' job have been listed in more details in the Table 16.

3.4.4.2. Psychosocial factors II: social support

Overall, most of the surgeons find their work place atmosphere comfortable and find adequate level of safeguard at their workplace. Table 17 shows the responses of the participants with more details.

Table 16 Psychosocial Factors Part I: Time Pressure, Job Control, and Work Schedule

	Open (n= 5)					Laparoscopic (n= 5)					Robotic (n= 2)				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I find surgical procedures hurried or rushed.	0	3	2	0	0	1	3	1	0	0	0	1	1	0	0
I find surgical tasks difficult and complex.	1	1	1	2	0	1	2	1	1	0	0	0	1	1	0
I find my operating environment distracting.	0	5	0	0	0	1	2	2	0	0	0	0	2	0	0
I have too many job tasks.	0	5	0	0	0	1	2	2	0	0	0	0	2	0	0
I feel pressured.	0	3	1	1	0	1	3	1	0	0	0	0	2	0	0
I take time to pause or stretch.	1	1	1	2	0	1	1	2	1	0	0	0	1	1	0
I can ask and enquire during performing surgery.	0	0	0	3	2	0	0	0	4	1	0	0	1	0	1
If I made a mistake during surgery, I find support from my colleagues.	0	1	1	1	2	0	0	0	3	2	0	0	0	1	1
My work tasks while performing surgery depend on other colleagues.	0	2	1	1	1	0	1	1	1	2	0	0	1	0	1
I experience communication breakdowns during surgery that lead to delays in surgery.	0	2	2	1	0	0	1	1	3	0	0	0	0	2	0

Table 17 Psychosocial Factors II: Social Support

Statements	Options				
	Exceptional	Adequate safeguards	Inadequate safeguards	No opinion	
level of safeguards are in place to prevent work-related injury to surgeons	0 (0%)	6 (85%)	3 (42%)	1 (14%)	
level of support is offered to surgeons' post-injury	1 (14%)	5 (71%)	3 (42%)	1 (14%)	
Level of access for supporting resources at your institution for injured surgeons	1 (14%)	4 (57%)	1 (14%)	2 (28%)	
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am anxious while performing surgery.	3 (42%)	2 (28%)	0 (0%)	2 (28%)	0 (0%)
My work atmosphere is comfortable.	0 (0%)	0 (0%)	0 (0%)	5 (71%)	2 (28%)

3.4.4.3. Ergonomic guidelines awareness among surgeons

Among the all seven participants of the study, three of them (42.85 %) stated that they are aware of the ergonomic guidelines (Table 1). However, one of the surgeons stated that he/she is aware of the guidelines but is not capable of applying them since the settings that satisfies his/her needs conflict with others. This may happen when more than one surgeons or assistants with different demographic characteristics use one operating room and one table height cannot provide a safe condition for all of the surgeons or assistants at the same time. In conclusion, the results of the survey indicate that only two out of the seven subjects (28.57 %) believe that they are aware of ergonomic guidelines and they apply them.

Table 18 Ergonomic Guideline Awareness among the Surgeons

	(n= 7)
No. of Surgeons aware of ergonomics guidelines, n (%)	3 (42.85 %)
No. of Surgeons apply ergonomics guidelines, n (%)	2 (28.57 %)
The reasons for not applying ergonomic guidelines, n	
They do not find ergonomic guidelines applicable	0
They cannot apply them because the ergonomics settings that satisfies their needs conflicts with others	1
They do not find ergonomic guidelines helpful	0

3.4.5. Short-term outcome measurements

3.4.5.1. Association between types of surgeries and physical discomfort among surgeons

Participants answered to the questions about the experience of discomfort in 22 body regions after performing each of open, laparoscopic, and robotic surgery. Figure 10 illustrates the rate of physical discomfort experienced by surgeons performing different surgical procedures. As you can see, surgeons stated that they experience discomfort at neck, right shoulder, left shoulder, upper back, lower back, left lower leg, right lower leg, and left lower leg.

The distribution of discomfort varies between different surgical procedures and techniques. The most problematic part of the body was neck. Hundred percent of the surgeons experience discomfort after performing open surgery. The rate of discomfort in neck is lower among laparoscopic and robotic surgeons compared with open surgeons. However, it is highly prevalent among surgeons and 75% of laparoscopic and 50% of robotic surgeons experience discomfort in neck after performing surgery. Discomfort in shoulder is more prevalent among laparoscopic surgeons compared with open and robotic surgery, as 50% of the surgeons experience discomfort after performing laparoscopic surgery. Low back and upper back discomfort also were more prevalent after performing open surgery compared with other types of surgical procedure. Discomfort in lower legs were only observed after performing open surgeries. After performing robotic surgery, surgeons only reported discomfort at upper back and neck. Overall in most of the body parts, the prevalence of discomfort was the lowest after performing robotic surgery and the highest after performing open surgery.

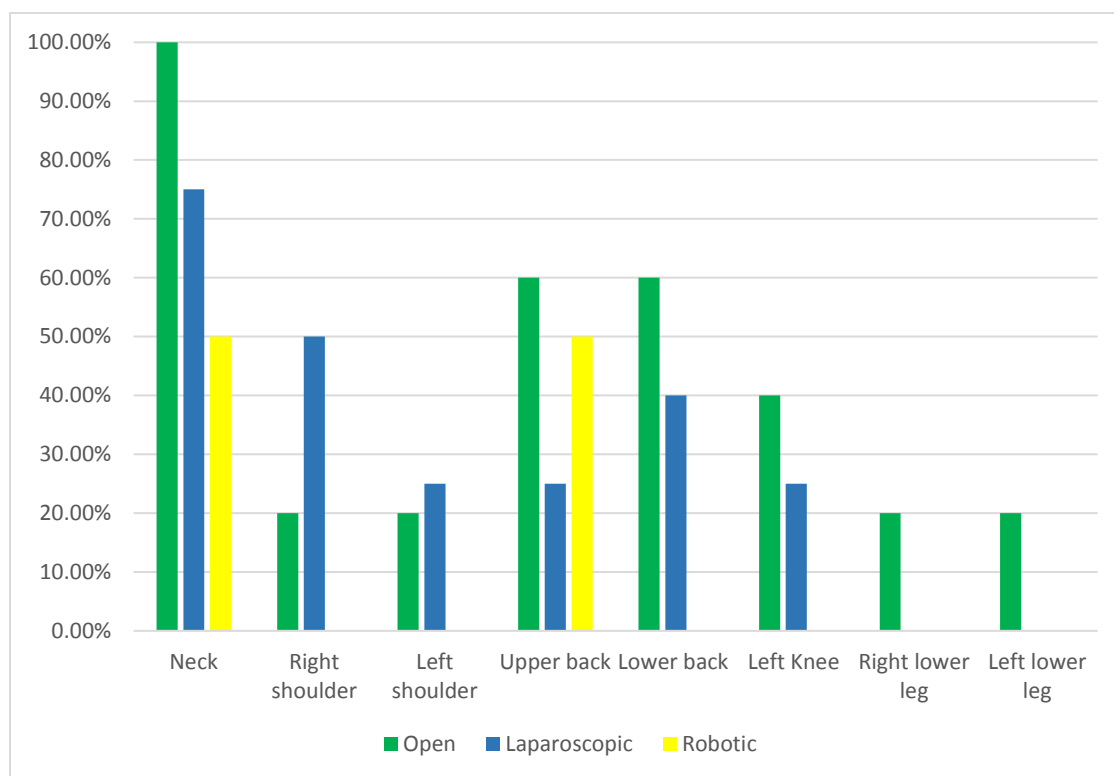


Figure 10 Physical Discomfort Grouped by Body Parts and Surgical Techniques

Figure 11 demonstrate the body parts that surgeons experienced discomfort after performing each of the surgical procedures on body maps. The body parts marked with red shows that more than half of the surgeons experienced discomfort after performing surgery. The yellow marks demonstrate the body regions in which surgeons felt discomfort. However, less than half of the surgeons experienced the discomfort. In the other parts of the body that are not marked, none of the surgeons experienced discomfort.

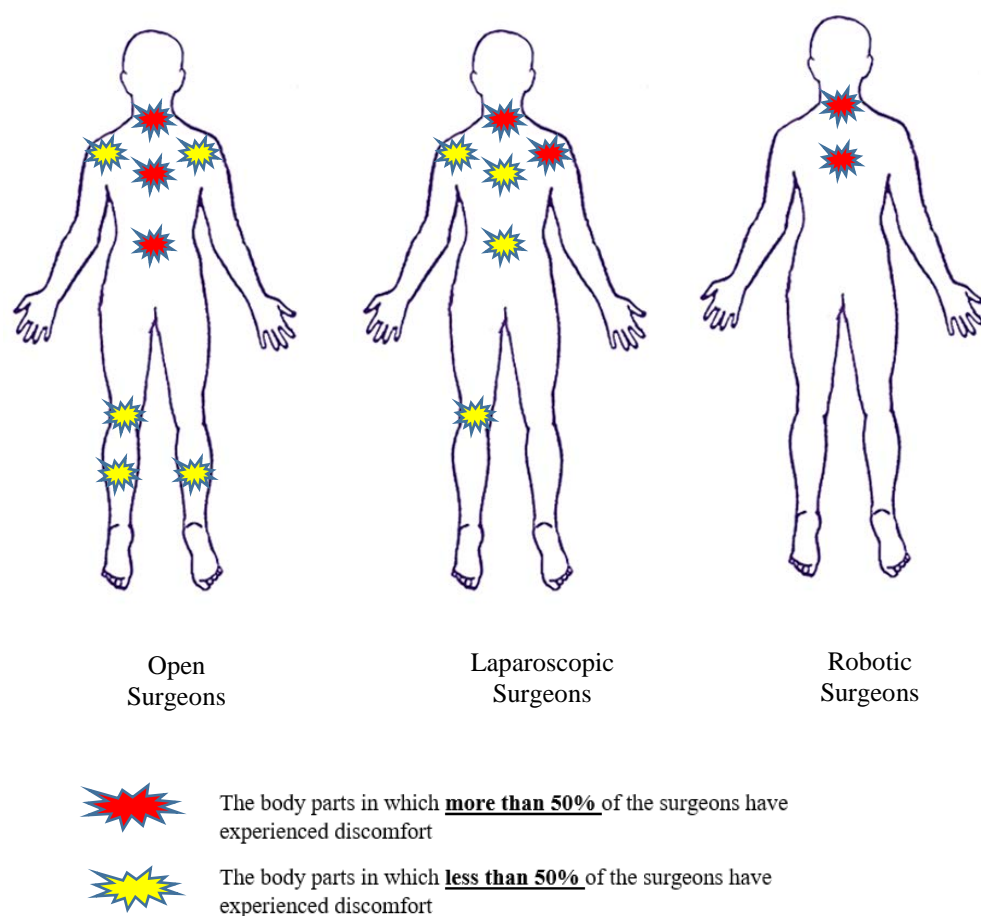


Figure 11 Physical Discomfort Grouped by Surgical Techniques

3.4.5.2. Association between ergonomic guideline awareness and physical discomfort among surgeons

As it was shown in section 3.4.5.2, 42% of the surgeons stated that they are aware of ergonomic guidelines and only 28% of the participants stated that they apply ergonomic guidelines. In this study, I want to investigate whether the level of discomfort is lower among surgeons who stated that they apply ergonomic guidelines. Figure 12, Figure 13, and Figure 14 indicate how the prevalence of discomfort rate are different among surgeons who apply or who do not apply the ergonomic guidelines after performing each of the

surgical procedures of open, laparoscopic, and robotic. As you can see in the figures, the people who stated that they do not follow the ergonomic guidelines have experienced discomfort in more parts of their bodies.

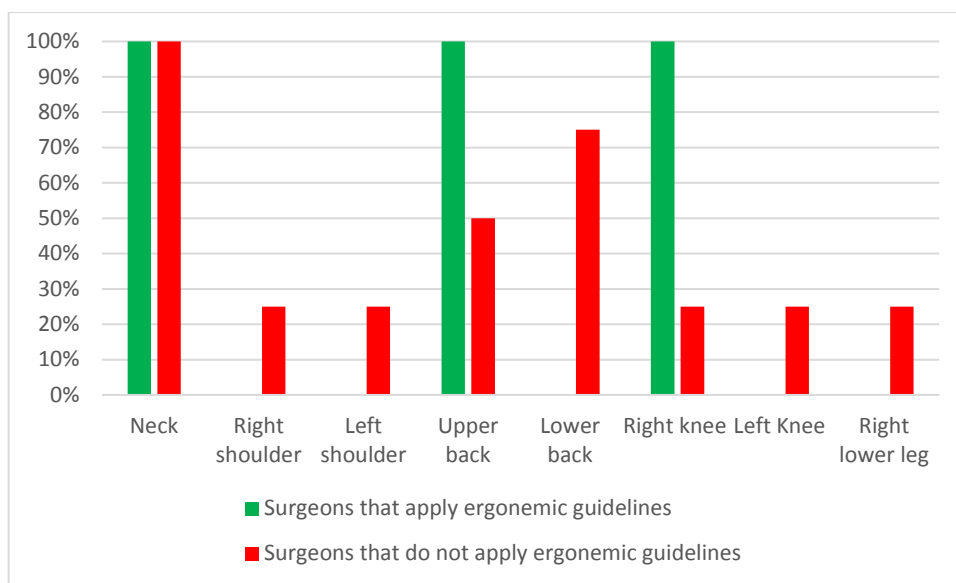


Figure 12 Comparing the Prevalence of Discomfort after Performing Open Surgery (N= 5) Between Surgeons Who Apply and Do Not Apply Ergonomic Guidelines

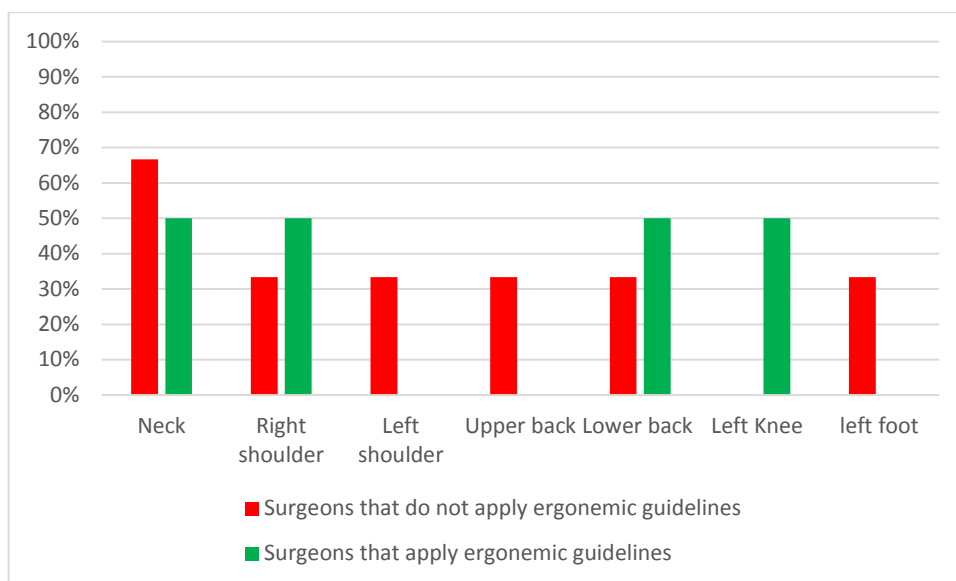


Figure 13 Comparing the Prevalence of Discomfort after Performing Laparoscopic Surgery (N= 5) Between Surgeons Who Apply and Do Not Apply Ergonomic Guidelines

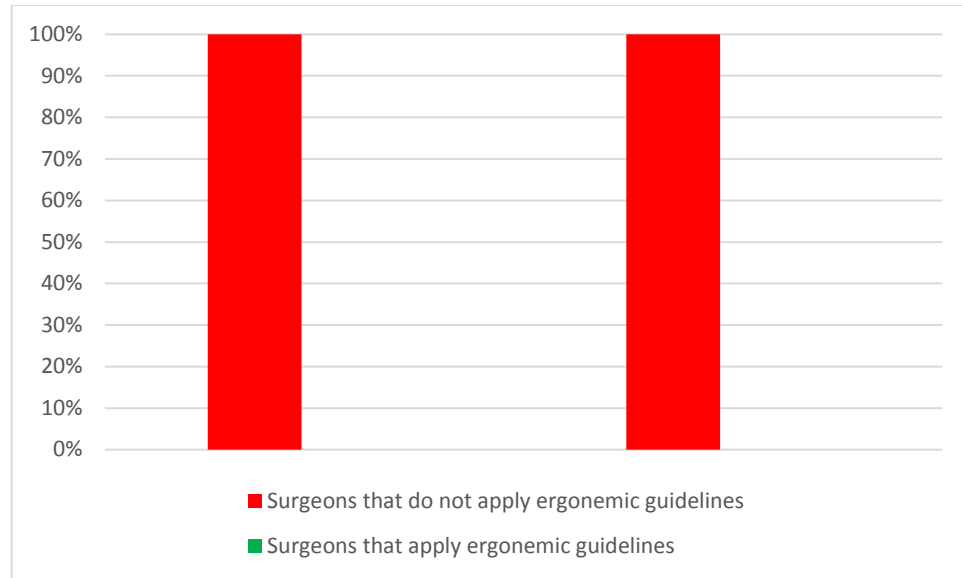


Figure 14 Comparing the Prevalence of Discomfort After Performing Robotic Surgery (N= 2) Between Surgeons Who Apply and Do Not Apply Ergonomic Guidelines

3.4.6. Long-term outcome measurements (WMSDs among surgeons)

The results of the questionnaire indicates that participants have been diagnosed with a variety of musculoskeletal disorder, which they contribute to their job, such as low back pain and prolapsed/herniated disc. Most of them have received treatments for their problems. However, only few of them have been hospitalized for their problems. Table 16 lists the history of WMSDs among the participants.

Table 19 History of Musculoskeletal Disorders among Surgeons (n= 7)

	Low back pain	Prolapsed / herniated disc	Shoulder pain (tendinitis)	Knee osteoarthritis	Rotator cuff injury	Bunion
No. of surgeons with history of MSDs	2	2	2	1	1	1
No. of surgeons who received treatment	0	2	1	1	1	1
No. of surgeons who hospitalized	0	1	0	1	0	0

3.5. Discussion

In this study, I used the comprehensive question pool that was developed in chapter 2 to create a questionnaire to investigate the risk factors of developing WMSDs among surgeons performing different surgical procedures of open, laparoscopic, and robotic. It was hypothesized that the level of risk factors is different while performing various surgical procedures. It was also hypothesized that prevalence of discomfort is lower among surgeons who are aware of ergonomic guidelines compared with those who are not aware of ergonomic guidelines. In addition, I tried to investigate the level of risk factors and prevalence of discomfort among surgeons and study the potential risk factors of developing WMSDs among surgeons and interactions between the risk factors.

Questions were selected from the comprehensive question pool to investigate demographic characteristics, individual factors, workload, physical risk factors, psychosocial factors, short-term and long-term outcome measurements. In order to facilitate the process of data collection and data analysis, Qualtrics (Qualtrics, Provo, UT) was used for collecting data. In order to improve the usability of the survey, the blocks of the questions were modified based on the experience of the surgeons. For example, if the participants did not have any experience of performing robotic surgery, he/she would not see the questions about robotic surgery. In addition, progress bar was added to the questionnaire interface to improve the user-friendliness of the survey.

Due to the time limitation, I was not able to recruit sufficient number of subjects to perform data analysis and test these hypotheses using a more valid method. Seven surgeons with different specialties and experience of performing various surgical procedures were participated in the survey.

The results indicate differences between different surgical techniques, open, laparoscopic, and robotic, in terms of the level of risk and discomfort. Surgeons participated in my study stated that they experience discomfort in their shoulders more frequently while performing laparoscopic surgery. The previous studies also indicate higher discomfort and muscle activity in shoulders while performing laparoscopic surgery in comparison with open surgery (Berguer R et al., 2003). This can be result of keeping shoulder in an awkward posture. As it was shown in the result section, that the participants in this study stated that they maintain their shoulder lifted for a longer period of time in comparison to open and robotic surgery. This can be a result of using instruments with long handles in laparoscopic surgeries. Low table height would reduce the strain in shoulder. However, if the laparoscopic surgeons need to view the patients located on the operating room table not using the monitor, the low height of the table may force the surgeons to bend neck or shoulder to compensate for that. Even though one of the previous studies shows that the muscle activity and discomfort in flexor digitorum is higher among laparoscopic surgeons compared to open surgeons, this study did not show any difference in duration of awkward posture and perceived discomfort in those body region (Berguer R et al., 2003). This inconsistency can be a result of limited number of subjects in this study.

The responses of the surgeons to the questions regarding their posture and discomfort while performing laparoscopic and robotic, indicates lower level of discomfort among robotic surgeons in all of the investigated body regions, except for upper back. The previous studies also show the same trend (Dalager et al., 2016; Hubert et al., 2013b; Gyusung I. Lee et al., 2014). The result of investigating participants' posture also indicated less prevalent awkward posture among robotic surgeons with exception for the bent knees,

in which robotic surgeons reported maintaining their knees bent for a longer period. This is because of the fact some of the surgical robots (e.g., da Vinci) has a surgical console, which requires surgeons to sit during the operation.

Comparing the prevalence of discomfort among surgeons who were aware of ergonomic guidelines and who were not aware of ergonomic guidelines shows that surgeons who were aware of ergonomic guidelines reported discomfort in fewer body parts. This findings support previous studies which showed that people who are aware ergonomic guidelines are less exposed to physical risk factors and experience less degree of discomfort and pain (Miller et al., 2012; Wauben, Veelen, Gossot, & Goossens, 2006). However, we should pay attention to this point that ergonomic guideline awareness is different from application of the guidelines correctly. Surgeons maybe aware of the ergonomic guidelines, but they may not have access to appropriate tools to apply them, as one of the participants in this study stated that he/she is aware of ergonomic guideline. However, he/she is not capable of apply them since applying them is in conflict with the needs of the other colleagues. Another point to consider is the point that surgeons may not be aware of the appropriate guidelines since performing each of the surgical techniques requires surgeons to follow different ergonomic guidelines.

General ergonomic guidelines recommend setting of the working surface at height of elbow for workstation while performing standing tasks (Das & Sengupta, 1996). In more details, height of above elbow height is recommended for precision work, height of below elbow height is recommended for light work, and the height of 4-6 inches below elbow height is recommended for heavy work. Regarding the height of the operating room table, it is important for the surgeons to have access to tables with adjustable heights to set

the height according their anthropometric measurements and the surgical tasks that they perform. Performing each types of surgical procedures different operating table height, due to variety of instruments and techniques. It has been recommended to set the laparoscopic surgery table height lower than the open surgery table height because the instruments for performing laparoscopic surgery are longer than the open surgery instruments. Therefore, setting the table height at higher levels will force the surgeons to keep their shoulders elevated and can result in fatigues in those areas. The results of the questionnaire indicted that all of the surgeons have access to adjustable table and most of them adjust the table height between upper thigh and elbow height. One of the participant stated that he/she set the table height for laparoscopic surgery higher than the height for open surgery. The results also indicated that that the same person hold more awkward posture in shoulder area while performing laparoscopic surgery in comparison to open surgery. In addition, the same surgeon expressed experiencing discomfort in right and left shoulder only after performing laparoscopic surgery, not open surgery.

Most of the open and laparoscopic surgeons participated in this study stated that they do not use sitting while performing surgery. The results indicated that the surgeons who use sitting stool while performing open surgery were the only surgeons who experience discomfort after performing surgery in right and left lower legs. This can be a result of limited number of subjects and other contributing factors in developing discomfort in those areas. It should be mentioned that all of the robotic surgeons in this study use sitting stool since the settings of the robots require surgeons to sit next to the surgical console, consists of display and controls. In comparison, to the open and laparoscopic

surgeons, robotic surgeons in this study experience lower level of discomfort in lower body parts, such as knees and lower legs.

Monitor was another part of the operating room settings that six out of the seven participants stated that they use monitor for various purposes during the performing surgery. Half of the surgeons stated that the height of the monitor is above their eye level. The responses of this group of surgeons also indicated that they hold their neck bent and twisted and they experience discomfort in the neck area. This shows that location of the monitor can be a contributing factor in developing discomfort in neck and WMSDs in neck in long term, especially for laparoscopic surgeons and robotic surgeons who use monitor for a long period of time for viewing inside the patients' body. In addition, one of the surgeons declared that the location of the monitor is off to side while he is performing open and laparoscopic surgery. He also stated that his neck is twisted while performing surgery and often feel discomfort after surgical procedure that is supports the hypothesis that not following ergonomic guidelines regarding the monitor settings can increase risk of discomfort in neck.

The results of the survey also indicated that open surgeons use arm support more frequently in comparison to laparoscopic surgeons. On the other hand, open surgeons suffer from shoulder discomfort less than laparoscopic surgeons. Even though, not using arm support can be a contributing factor in the frequency of discomfort in shoulder, there are other factors involved, such as surgical instrument and table height, that can could have been influential in the mentioned differences observed between open and laparoscopic surgeons in terms of shoulder discomfort.

The results of the questionnaire also indicate that surgeons tend to maintain their necks bent for a longer duration of time compared with laparoscopic surgery. This finding supports the previous studies findings, as it has been shown that the duration of neck awkward posture and degree of muscle activity is higher among open surgeon (Berguer et al., 1997; Grace P.Y. Szeto et al., 2012, 2012). The results of the survey also indicated high level of discomfort in neck among open surgeons. Keeping awkward posture in neck can be considered as a contributing factor to this high prevalence of discomfort at neck among the open surgeons.

Overall, conducting this pilot study helped us to investigate the risk factors associated with developing WMSDs among surgeons and compare those factors between surgeons with different backgrounds and experiences. The main limitation of this pilot study was limited number of participants. In the future study, the survey can be conducted among larger population of surgeons and comprehensive data analysis can be performed to investigate the risk factors of developing WMSDs among surgeons and provide safer workplace for surgeons in future.

4. CHAPTER 4: CONCLUSION

The proposed study was consisting of two main parts. In the first part, a systematic review was conducted to assess the subjective tools that have been used to investigate the risk factors of developing WMSDs among surgeons and create a comprehensive question pool using the popular subjective tools to help the researchers to develop questionnaire more efficiently. In the second part, a questionnaire was designed using the developed comprehensive part in the first part to investigate the risk factor of developing WMSDs among surgeons while performing surgical procedures of open, laparoscopic, and robotic. The level of ergonomic guidelines awareness and its association with risk of developing WMSDs were also investigated. In addition any associations between risk factors were studied in this study. The summary of the findings and recommendation for future research will be presented.

4.1. Summary of the findings

- The risk factors of developing WMSDs among surgeon were categorized into four main groups of physical, cognitive, psychosocial, and individual factors.
- Four groups of risk factors got different levels of attention in comparison to other identified tools. Physical and individual risk factors got more attention compared with psychosocial and cognitive risk factors.
- Short-term outcome measurements, such as pain, discomfort, and stiffness, were studied more in comparison to long-term outcome measurements, such as disability and MSDs
- Ergonomic guideline awareness has received the least attention among the other psychosocial risk factors.

- The NASA-TLX and Nordic Musculoskeletal questionnaires were the most popular tools for investigating the level of risk factors.
- A comprehensive question pool was developed using the existing tools. In addition, self-developed questions were added to the comprehensive question pool. Questions were categorized into four main groups of risk factors—physical, cognitive, psychosocial, and individual risk factors—and two groups of outcome measurements—short-term and long-term outcome measurements—to help the researchers to investigate the risk factors in more efficient way.
- A questionnaire was designed using the developed comprehensive question pool and seven surgeon participate in the survey.
- The results of the survey showed that the level of risk factors and prevalence of WMSDs are different among surgeons who perform different techniques of surgeries, open, laparoscopic, and robotic. For example, open surgeons maintain awkward posture in their neck more than the laparoscopic surgeons. In addition, the level of discomfort was different among surgeons who perform different surgical procedures. For example, neck pain were more prevalent after performing open surgery compared with laparoscopic and robotic surgery. Surgeons also experienced discomfort in shoulder more often after performing laparoscopic surgery in comparison with open and robotic surgery.
- The level of risk of developing WMSDs was lower among surgeons who are aware of ergonomic guidelines compared with surgeons who are not aware of

ergonomic guidelines. As it was shown that surgeons who were not aware of ergonomic guidelines experience discomfort in more parts of their body.

- The high level of risk factor increase the chance of developing WMSDs among the surgeons. For example, the surgeons who held their necks in awkward posture for a long period of time had higher prevalence of discomfort in their neck compared with the other surgeons.

4.2. Recommendations for future research

- More subjects should be recruited to provide enough sample of data to perform data analysis techniques and investigate the association between the risk factors.
- In addition to open, laparoscopic, and robotic surgical techniques, other surgical techniques can be investigated in future studies.
- The offered methodology can be used to investigate the risk factors among other occupations.

5. APPENDICES

5.1. APPENDIX 1: Comprehensive question Pool

5.1.1. Comprehensive question pool part I: Risk factors

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 1	NASA-TLX (Hart, 2006)	Cognitive factors	Mental demand	How mentally demanding was the task?
Q 2	NASA-TLX	Physical factors	Physical demand	How physically demanding was the task?
Q 3	NASA-TLX	Psychosocial factors	Temporal demand	How hurried or rushed was the pace of the task?
Q 4	NASA-TLX	Psychosocial factors	Performance	How successful were you in accomplishing what you were asked to do?
Q 5	NASA-TLX	Cognitive factors	Effort	How hard did you have to work to accomplish your level of performance?
Q 6	NASA-TLX	Psychosocial factors	Frustration	How insecure, discouraged, irritated, stressed, and annoyed were you?
Q 7	SURG-TLX	Cognitive factors	Mental demand	How mentally fatiguing was the procedure?
Q 8	SURG-TLX	Physical factors	Physical demand	How physically fatiguing was the procedure?
Q 9	SURG-TLX	Psychosocial factors	Temporal demand	How hurried or rushed was the pace of the procedure?
Q 10	SURG-TLX	Psychosocial factors	Effort	How complex was the procedure?
Q 11	SURG-TLX	Psychosocial factors	Frustration	How anxious did you feel while performing the procedure?
Q 12	SURG-TLX	Psychosocial factors	Frustration	How distracting was the operating environment?
Q 13	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms (Kuorinka et al., 1987a)	Individual factors	General demographic characteristics	Sex?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 14	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Individual factors	General demographic characteristics	What year were you born?
Q 15	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Individual factors	Experience	how many years and months have you been doing your present type of work?
Q 16	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Psychosocial factors	Work schedule	On average, How many hours a week do you work?
Q 17	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Individual factors	General demographic characteristics	Weight?
Q 18	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Individual factors	General demographic characteristics	Height?
Q 19	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Individual factors	General demographic characteristics	Are you right-handed or left-handed?
Q 20	Version of Standardized Nordic Musculoskeletal	Physical factors	Posture	During my work I keep a good work posture. (Always, Sometimes, Never)

Question No.	Tool	Category of risk factor	Risk factor	Question
	Questionnaire (NMQ-E) (Roja et al., 2015b)			
Q 21	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	At work I sit for long hours in one position. (Always, Sometimes, Never)
Q 22	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	For more than two hours per day Is it with lifted shoulders . (Always, Sometimes, Never)
Q 23	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Physical demand	I find my job physically exhausting. (Always, Sometimes, Never)
Q 24	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	When I key my hand is placed in a s straight line with my lower arm. (Always, Sometimes, Never)
Q 25	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	When I work my head is bended. (Always, Sometimes, Never)
Q 26	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	Head is twisted towards the left or right. (Always, Sometimes, Never)
Q 27	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	Trunk is twisted towards the left or right. (Always, Sometimes, Never)
Q 28	version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Physical factors	Posture	My Trunk is in asymmetrical position. (Always, Sometimes, Never)
Q 29	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Psychological stress	I work under extensive work pressure. (Always, Sometimes, Never)
Q 30	Extended version of Standardized Nordic	Psychosocial factors	Time pressure	I have no enough time to finish my job task. (Always, Sometimes, Never)

Question No.	Tool	Category of risk factor	Risk factor	Question
	Musculoskeletal Questionnaire (NMQ-E)			
Q 31	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Time pressure	At work I speed to finish my tasks on time. (Always, Sometimes, Never)
Q 32	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Cognitive factors	Cognitive task difficulty	I find my work tasks difficult. (Always, Sometimes, Never)
Q 33	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Work schedule	I have too many job tasks . (Always, Sometimes, Never)
Q 34	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Work schedule	The work flow goes smoothly. (Always, Sometimes, Never)
Q 35	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Social support	I can ask and enquire in my work. (Always, Sometimes, Never)
Q 36	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Sense of community	My work tasks depend on other co-workers. (Always, Sometimes, Never)
Q 37	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Psychological stress	My work atmosphere is comfortable. (Always, Sometimes, Never)
Q 38	Extended version of Standardized Nordic	Psychosocial factors	Social support	If I made a mistake in my work I find support from my co-workers. (Always, Sometimes, Never)

Question No.	Tool	Category of risk factor	Risk factor	Question
	Musculoskeletal Questionnaire (NMQ-E)			
Q 39	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Social support	If I made a mistake in work task I find support from supervisors. (Always, Sometimes, Never)
Q 40	Extended version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Psychosocial factors	Social support	My colleagues are friendly. (Always, Sometimes, Never)
Q 41	Workstyle Short Form (Feuerstein & Nicholas, 2006)	Psychosocial factors	Psychosocial stress	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I continue to work with pain and discomfort so that the quality of my work won't suffer. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 42	Workstyle Short Form	Psychosocial factors	Job control	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. Since there is really nothing that I can do about my pain in my hands/arms/shoulders/neck, I just have to work through the pain. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 43	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I can't take off from work because other people at work will think less of me. (Almost never, Rarely, Sometimes, Frequently, Almost always)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 44	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I can't take off from work because I'd be letting down or burdening my boss. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 45	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I can't take off from work because I'd be letting down or burdening my co-workers.
Q 46	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I can't take off from work because it will negatively affect my evaluations, promotions and/or job security.
Q 47	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. If I take time off to take care of my health or to exercise, my co-workers/boss will think less of me. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 48	Workstyle Short Form	Psychosocial factors	Psychosocial stress	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I don't really know where I stand despite all the effort I put into my work. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 49	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. The boss doesn't let you forget it if you don't get your

Question No.	Tool	Category of risk factor	Risk factor	Question
				work finished. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 50	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. If I bring up problem(s) to my supervisor, like a coworker not pulling his/her weight, it won't make any difference anyway, so I just go ahead and do the work myself. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 51	Workstyle Short Form	Psychosocial factors	Psychosocial stress	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. It is frustrating to work for those who don't have the same sense of quality that I do. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 52	Workstyle Short Form	psychosocial factors	Time pressure	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I have too many deadlines and will never be able to get all my work done. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 53	Workstyle Short Form	Psychosocial factors	Job control	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. Even if I organize my work so that I can meet deadlines, things change and then I have to work even harder to get my work done on time. (Almost never, Rarely, Sometimes, Frequently, Almost always)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 54	Workstyle Short Form	Psychosocial factors	Job control	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. My schedule at work is very uncontrollable. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 55	Workstyle Short Form	Psychosocial factors	Psychosocial stress	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I feel pressured when I'm working at my workstation. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 56	Workstyle Short Form	Psychosocial factors	Psychosocial stress	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I push myself and have higher expectations than my supervisor and others that I have to deal with at work. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 57	Workstyle Short Form	Psychosocial factors	Social support	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. My co-workers don't pull their weight and I have to take up the slack. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 58	Workstyle Short Form	Psychosocial factors	Psychosocial stress	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. Others tell me I should slow down and not work so hard. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 59	Workstyle Short Form	Psychosocial factors	Job control	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option.

Question No.	Tool	Category of risk factor	Risk factor	Question
				I take time to pause or stretch during a typical day at work. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 60	Workstyle Short Form	Psychosocial factors	Job control	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I take breaks when I am involved in a project at my workstation. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 61	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire (Berguer, 1998)	Cognitive factors	Mental demand	Have you experienced any of the following problems during or following laparoscopic surgery? (Mental fatigue/ irritability/ exhaustion)
Q 62	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Cognitive factors	Mental demand	Have you experienced any of the following problems during or following laparoscopic surgery? Excessive tachycardia/ sweating/tremors
Q 63	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Physical factors	Workstation configuration	Have you experienced any of the following problems during or following laparoscopic surgery?(Inability to visualize operative field properly)
Q 64	Society of American Gastrointestinal and Endoscopic Surgeons	Physical factors	Instruments manipulation	Have you experienced any of the following problems during or following laparoscopic surgery? Instruments awkward to manipulate

Question No.	Tool	Category of risk factor	Risk factor	Question
	(SAGES) Ergonomics Questionnaire			
Q 65	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Physical factors	posture	Have you experienced any of the following problems during or following laparoscopic surgery? Not able to perform fine or precision motion
Q 66	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Physical factors	Workstation configuration	Have you experienced any of the following problems during or following laparoscopic surgery? Reverse image when on opposite side of table
Q 67	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Psychosocial factors	Sense of community	Have you experienced any of the following problems during or following laparoscopic surgery? Slow setup/takedown times
Q 68	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Physical factors	posture	Have you experienced any of the following problems during or following laparoscopic surgery? Difficulty positioning yourself around the OR table
Q 69	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Psychosocial factors	Social support	Have you experienced any of the following problems during or following laparoscopic surgery? Inference between members of operative team
Q 70	Subjective Mental Effort Questionnaire (SMEQ) Questionnaire (Houwing et al., 1993)	Cognitive factors	Cognitive task difficulty	please score the amount of effort it took you to execute the task you have been working on by marking one of the anchors on the vertical line here below.(0-No effort at all, 150)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 71	University of Michigan Upper Extremity Questionnaire (Salerno et al., 2001)	Individual factors	General demographic characteristics	Demographic characteristics?
Q 72	University of Michigan Upper Extremity Questionnaire	Individual factors	Health condition	Medical history (history of injury and disease)?
Q 73	University of Michigan Upper Extremity Questionnaire	Individual factors	General demographic characteristics	Exercise habits?
Q 74	University of Michigan Upper Extremity Questionnaire	Individual factors	General demographic characteristics	Employment status?
Q 75	Safety Attitudes Questionnaire (SAQ)-short form (Sexton et al., 2006)	Psychosocial factors	Social support	Nurse input is well received in this clinical area.
Q 76	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	In this clinical area, it is difficult to speak up if I perceive a problem with patient care.
Q 77	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Disagreements in this clinical area are resolved appropriately (i.e., not who is right, but what is best for the patient).
Q 78	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I have the support I need from other personnel to care for patients.
Q 79	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	It is easy for personnel here to ask questions when there is something that they do not understand.
Q 80	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	The physicians and nurses here work together as a well-coordinated team.

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 81	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychosocial stress	I would feel safe being treated here as a patient.
Q 82	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychosocial stress	Medical errors are handled appropriately in this clinical area.
Q 83	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I know the proper channels to direct questions regarding patient safety in this clinical area.
Q 84	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I receive appropriate feedback about my performance.
Q 85	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	In this clinical area, it is difficult to discuss errors.
Q 86	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I am encouraged by my colleagues to report any patient safety concerns I may have.
Q 87	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	The culture in this clinical area makes it easy to learn from the errors of others.
Q 88	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	My suggestions about safety would be acted upon if I expressed them to management.
Q 89	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	I like my job.
Q 90	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Working here is like being part of a large family.

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 91	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	This is a good place to work.
Q 92	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	I am proud to work in this clinical area.
Q 93	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	Morale in this clinical area is high.
Q 94	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	When my workload becomes excessive, my performance is impaired.
Q 95	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	I am less effective at work when fatigued.
Q 96	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	I am more likely to make errors in tense or hostile situations.
Q 97	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Psychological stress	Fatigue impairs my performance during emergency situations (e.g. emergency resuscitation, seizure).
Q 98	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Management supports my daily efforts:
Q 99	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Management doesn't knowingly compromise pt. safety:
Q 100	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Management is doing a good job:

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 101	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Problem personnel are dealt with constructively by our:
Q 102	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I get adequate, timely info about events that might affect my work.
Q 103	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Time pressure	The levels of staffing in this clinical area are sufficient to handle the number of patients.
Q 104	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	This hospital does a good job of training new personnel.
Q 105	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	All the necessary information for diagnostic and therapeutic decisions is routinely available to me.
Q 106	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Trainees in my discipline are adequately supervised.
Q 107	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I experience good collaboration with nurses in this clinical area.
Q 108	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I experience good collaboration with staff physicians in this clinical area.
Q 109	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	I experience good collaboration with pharmacists in this clinical area.
Q 110	Safety Attitudes Questionnaire (SAQ)-short form	Psychosocial factors	Social support	Communication breakdowns that lead to delays in delivery of care are common

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 111	Safety Attitudes Questionnaire (SAQ)-short form	Individual factors	General demographic characteristics	Position? Attending/Staff Physician Fellow Physician Resident Physician Physician Assistant/Nurse Practitioner Nurse Manager/Charge Nurse Position: (mark only one) Registered Nurse Pharmacist Therapist (RT, PT, OT, Speech) Clinical Social Worker Dietician/Nutritionist Clinical Support (CMA, EMT, Nurses Aide, etc.) Technologist/Technician (e.g., Surg., Lab, Rad.) Admin Support (Clerk/Secretary/Receptionist) Environmental Support (Housekeeper) Other Manager (e.g., Clinic Manager) Other: _____
Q 112	Safety Attitudes Questionnaire (SAQ)-short form	Individual factors	General demographic characteristics	gender?
Q 113	Safety Attitudes Questionnaire (SAQ)-short form	Individual factors	Experience	Years in specialty: Less than 6 months 6 to 11 mo. 1 to 2 yrs. 3 to 4 yrs. 5 to 10 yrs. 11 to 20 yrs. 21 or more
Q 114	12-item General Health Questionnaire (GHQ-12) (Goldberg et al., 1997)	Psychosocial factors	Psychosocial stress	Lost much sleep over worry?
Q 115	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Felt constantly under strain?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 116	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been able to concentrate on what you are doing?
Q 117	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Felt that you are playing useful part in things?
Q 118	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been able to face up to your problem?
Q 119	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Felt capable of making decisions about things?
Q 120	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Felt you could not overcome your difficulties?
Q 121	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been feeling reasonably happy, all things considered?
Q 122	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been able to enjoy your normal day to day activities?
Q 123	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been feeling unhappy or depressed?
Q 124	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been losing confidence in yourself?
Q 125	12-item General Health Questionnaire (GHQ-12)	Psychosocial factors	Psychosocial stress	Been thinking of yourself as a worthless person?
Q 126	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons (Wauben, Veelen, et al., 2006)	Cognitive factors	Cognitive factors	What kind of endoscopic procedures do you perform?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 127	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Individual factors	Experience	How many hours a day (mean time) do you perform endoscopic procedures?
Q 128	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	What is normally the table height during the incision and placement of the trocars? Table height (distance from the top of the table to the floor)
Q 129	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	What is the table height during the actual operation? table height (distance from the top of the table to the floor)
Q 130	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	How would you rate the table height? Table height (distance from the top of the table to the floor)
Q 131	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Do you think the height range of the operating table is appropriate for endoscopic surgery? If your answer is no, should it be possible to lower or raise it more, or both? table height (distance from the top of the table to the floor)
Q 132	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 (I do not agree) to 5 (I fully agree), with the next propositions. I experience discomfort in my neck due to a bad table height.

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 133	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 (I do not agree) to 5 (I fully agree), with the next propositions. I experience discomfort in my shoulders due to a bad table height.
Q 134	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	How many monitors are used?
Q 135	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	What kind of monitors are used?
Q 136	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Where are the monitors placed?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 137	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Are you hindered by the position of the monitors? If yes, how are you hindered?
Q 138	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 to 5 with the next propositions. I experience discomfort in my neck due to a bad monitor height.
Q 139	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 to 5 with the next propositions. I experience discomfort in my neck due to a bad monitor position.
Q 140	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 to 5 with the next propositions. I experience discomfort in my neck due to a bad monitor height.
Q 141	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 to 5 with the next propositions. I experience discomfort in my neck due to a bad monitor position.
Q 142	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	What do you use to activate the diathermic or the ultrasonic equipment?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 143	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Do you find the use of the commonly used foot pedals comfortable?
Q 144	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	How would you prefer to control the diathermic or the ultrasonic equipment?
Q 145	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 to 5, with the next propositions? I experience discomfort in my legs and foot due to use of the foot pedals.
Q 146	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Physical factors	Workstation configuration	Indicate your extent of agreement, from 0 to 5, with the next propositions? I experience discomfort in my legs and foot due to use of the foot pedals.

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 147	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Psychosocial factors	Ergonomics guidelines awareness	Are you aware of any guidelines for endoscopic surgery in the literature concerning the table height and placement of the monitor and instruments?
Q 148	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons	Psychosocial factors	Ergonomics guidelines awareness	Do you think that the ergonomic conditions in the operating room are important?
Q 149	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance (Santos-Carreras, Hagen, Gassert, & Bleuler, 2012)	Individual factors	General demographic characteristics	Field of expertise?
Q 150	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	General demographic characteristics	institution?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 151	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	General demographic characteristics	age?
Q 152	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	General demographic characteristics	gender ?
Q 153	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	General demographic characteristics	country?
Q 154	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	Experience	Years of experience in open surgery?
Q 155	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	Experience	Years of experience in laparoscopic surgery?
Q 156	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	Experience	Years of experience in robotic surgery?
Q 157	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Individual factors	Experience	Average number of hours that surgical procedures last?
Q 158	FESS, fingers and other things--you are not alone! (Amin, Rimmer, Swift, White, & Lund, 2015)	Individual factors	General demographic characteristics	How old are you 30-40 <input type="checkbox"/> 40-50 <input type="checkbox"/> 50-60 <input type="checkbox"/> > 60 <input type="checkbox"/>

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 159	FESS, fingers and other things--you are not alone!	Individual factors	General demographic characteristics	How old are you 30-40 <input type="checkbox"/> 40-50 <input type="checkbox"/> 50-60 <input type="checkbox"/> > 60 <input type="checkbox"/>
Q 160	FESS, fingers and other things--you are not alone!	Individual factors	Experience	How many ESS procedures do you undertake per year? Less than 50 <input type="checkbox"/> 50-100 <input type="checkbox"/> more than 100 <input type="checkbox"/>
Q 161	FESS, fingers and other things--you are not alone!	Individual factors	Experience	How many years have you been performing ESS? 1-5 <input type="checkbox"/> 5-10 <input type="checkbox"/> 10-20 <input type="checkbox"/> 20-30 <input type="checkbox"/>
Q 162	FESS, fingers and other things--you are not alone!	Physical factors	Posture	In your practice do you perform ESS sitting or standing? Sitting <input type="checkbox"/> Standing <input type="checkbox"/>
Q 163	FESS, fingers and other things--you are not alone!	Individual factors	General demographic characteristics	Are you Right or Left Handed? Right handed <input type="checkbox"/> Left handed <input type="checkbox"/>
Q 164	FESS, fingers and other things--you are not alone!	Physical factors	Posture	Do you stand on the right side of the operating table or the left side of the operating table? Right side <input type="checkbox"/> Left side <input type="checkbox"/>
Q 165	FESS, fingers and other things--you are not alone!	Physical factors	Workstation configuration	During ESS do you use the beam splitter or the monitor screen only to operate? Beam splitter <input type="checkbox"/> Monitor screen only <input type="checkbox"/>
Q 166	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions (Amin et al., 2015)	Psychosocial factors	Social support	Do you know how to report a workplace injury?(yes, No)
Q 167	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Psychosocial factors	Social support	What level of safeguards are in place to PREVENT work-related injury to surgeons (ex: ergonomic workplace, personal protective equipment)? (Exceptional safeguards, Adequate safeguards, Inadequate safeguards, No opinion)
Q 168	Musculoskeletal occupational injury	Psychosocial factors	Social support	What level of support is offered to surgeons POST-INJURY (ex: rehabilitation, return to work programs)?

Question No.	Tool	Category of risk factor	Risk factor	Question
	among surgeons: effects for patients, providers, and institutions			(Exceptional support, Adequate support, Inadequate support, No opinion)
Q 169	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Psychosocial factors	Social support	How accessible are supportresources at your institution for injured surgeons? (Very accessible, Somewhat accessible, inaccessible, No opinion)
Q 170	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	General demographic characteristics	What is your gender?
Q 171	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	General demographic characteristics	What is your height (in inches)?
Q 172	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	General demographic characteristics	What is your approximate weight (in pounds)?
Q 173	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	What is you specialty? (General, Neurological, Obstetrics, Gynecology, Ophthalmology, Orthopedic, Otolaryngology, Plastic, Urology, Other)
Q 174	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	Which of the following most accurately describes your practice setting?(Academic, Private, Other(Military, Health Maintenance organization, etc.))

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 175	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	How many years have been performing surgery (including residency)?
Q 176	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	During a typical week, how many hours do you perform surgery?
Q 177	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	During a typical week, how many total hours do you work (including surgery, clinic, consultations, etc.)?
Q 178	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	During a typical 24 hours period, how many hours do you sleep? (1-2 h, 3-4h, 5-6 h, 7-8 h, 9 or more hours)
Q 179	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Individual factors	Experience	During a typical week, how many days do you exercise for 30 minutes or more?(0 days, 1-2 days, 3-5 days, 6-7 days)
Q 180	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	Psychosocial factors	Psychosocial support	Please give any suggestion on how to improve workplace safety or provide better support to injured surgeons: (optional)
Q 181	Work environment discomfort and injury: an	Individual factors	General demographic characteristics	What is your age?

Question No.	Tool	Category of risk factor	Risk factor	Question
	ergonomic survey study of the American Society of Pediatric Otolaryngology members (Cavanagh et al., 2012b)			
Q 182	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	General demographic characteristics	What is your height (cm)?
Q 183	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	General demographic characteristics	What is your gender?
Q 184	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	General demographic characteristics	What is your dominant hand?
Q 185	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	Experience	How many years have you been practicing?
Q 186	Work environment discomfort and injury: an ergonomic survey study of the American Society	Individual factors	Experience	What is your type of practice? (Please circle) Academic or Private Practice

Question No.	Tool	Category of risk factor	Risk factor	Question
	of Pediatric Otolaryngology members			
Q 187	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	Experience	How many years have you been practicing?
Q 188	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	Experience	What is your type of practice? (Please circle) Academic or Private Practice
Q 189	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	Experience	Are you fellowship trained? (Please circle) Yes or No
Q 190	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Individual factors	Experience	How many of the following cases do you perform in a year? Minor microscopy cases (e.g. tympanostomy tube, myringoplasty) Major microscopy cases (e.g. mastoidectomy, microvascular) Minor endoscopy cases (e.g. diagnostic bronchoscopy) Major endoscopy cases (e.g. FESS)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 191	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Psychosocial factors	Ergonomics guidelines awareness	Are you aware of the recommendations made by the field of surgical ergonomics, its studies and research? (Please circle) Yes or No If yes, where did you acquire this information? (Please circle) Word of mouth Internet search Conference or meeting Others:
Q 192	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Psychosocial factors	Ergonomics guidelines awareness	Have you applied any of this information to your surgical practice? Yes or No If yes, what were the results?
Q 193	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Psychosocial factors	Ergonomics guidelines awareness	Would you like more information regarding surgical ergonomics? (Please circle) Yes or No If yes, what format would you prefer? (Please circle) Newsletters Website Sessions or course
Q 194	Patients Benefit While Surgeons Suffer: An Impending Epidemic (A. Park et al., 2010)	Individual factors	General demographic characteristics	What is your age?
Q 195	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Individual factors	General demographic characteristics	What is your height?
Q 196	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Individual factors	General demographic characteristics	What is your gender?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 197	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Individual factors	General demographic characteristics	What is your dominant hand?
Q 198	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Individual factors	Experience	How many laparoscopic cases do you perform a year?
Q 199	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Individual factors	Experience	Have you completed a laparoscopic fellowship?
Q 200	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Individual factors	Experience	How many years have you been practicing laparoscopic surgery?
Q 201	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Psychosocial factors	Ergonomics guidelines awareness	How aware are you of the recommendations made by the field of surgical ergonomics, its studies and research?Where did you acquire this information?Have you applied any of this information to your surgical practice?
Q 202	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Workstation configuration	What references do you use when adjusting the operating room table height? What kind of display system do you use?
Q 203	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Workstation configuration	What kind of display system do you use?
Q 204	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Workstation configuration	How is your display system mounted?
Q 205	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Workstation configuration	Improving which of these display parameters would be most helpful to you?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 206	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Instruments manipulation	What size surgical gloves do you wear?
Q 207	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Instruments manipulation	Do you feel that the laparoscopic instrument handles are:
Q 208	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Physical factors	Instruments manipulation	If available, would you utilize laparoscopic instruments in more lengths?
Q 209	Comparison of Neuromuscular Injuries to the Surgeon during Hand-Assisted and Standard Laparoscopic Urologic Surgery (W. K. Johnston, Hollenbeck, & Wolf, 2005)	Physical factors	Instruments manipulation	What type of hand-port do you routinely use?(Gelport, Lap disc, ominiport, other)
Q 210	Comparison of Neuromuscular Injuries to the Surgeon during Hand-Assisted and Standard Laparoscopic Urologic Surgery	Individual factors	Experience	How many SL cases do you perform average per month as responsible surgeon
Q 211	Articulating vs. conventional laparoscopic grasping tools—surgeons' opinions (Trejo, Doné, DiMartino, Oleynikov, & Hallbeck, 2006)	Physical factors	Instruments manipulation	Do you normally experience any of the following problem during or following laparoscopic surgery?(No, slight, substantial) Instruments awkward manipulate not able to perform fine or revision motions
Q 212	Articulating vs. conventional laparoscopic	Physical factors	Instruments manipulation	How comfortable is the tool handle in your hand? (Extremely uncomfortable, uncomfortable, indifferent, comfortable, extremely comfortable)

Question No.	Tool	Category of risk factor	Risk factor	Question
	grasping tools—surgeons' opinions			
Q 213	Improved usability of a new handle design for laparoscopic dissection forceps (Veelen, Meijer, Goossens, Snijders, & Jakimowicz, 2002)	Physical factors	Instruments manipulation	To what extent do the dimensions of the handles agree with your hand dimensions?
Q 214	MIS instruments (Matern, Eichenlaub, Waller, & Rückauer, 2014)	Physical factors	Instruments manipulation	How safe does the handle feel in your hand?
Q 215	MIS instruments	Physical factors	Instruments manipulation	How precisely can you work with the handle?
Q 216	MIS instruments	Physical factors	Instruments manipulation	Evaluate the opening and closing function?
Q 217	MIS instruments	Physical factors	Instruments manipulation	Evaluate the rotating function?
Q 218	MIS instruments	Physical factors	Instruments manipulation	How easy is it to get used to the handle?
Q 219	MIS instruments	Physical factors	Instruments manipulation	What is your general impression of the handle?
Q 220	Improvement of foot pedals used during surgery based on new ergonomic guidelines (Veelen, Snijders, Leeuwen, Goossens, & Kazemier, 2003)	Individual factors	Experience	What is your function (surgeon/resident)?
Q 221	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Individual factors	General demographic characteristics	What is your gender?
Q 222	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Individual factors	Experience	How many years experience do you have in laparoscopy?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 223	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you use both functions of a foot pedal (cutting and coagulation)?
Q 224	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	How frequently do you use the function of coagulation compared to the function of cutting?
Q 225	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you use other equipment during surgery that is operated by foot pedals besides the diathermic equipment?
Q 226	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	How many foot pedals do you use during laparoscopic surgery? Use of the foot pedal
Q 227	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you sometimes lose contact with the foot pedal?
Q 228	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you sometimes lose contact with the foot pedal?
Q 229	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Does it annoy you when you lose contact with the foot pedal?
Q 230	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	How do you regain control over the foot pedal (multiple options possible)?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 231	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you keep the same posture during surgery to prevent loss of contact with the foot pedal?
Q 232	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you keep one foot above the foot pedal during surgery?
Q 233	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Does the foot pedal obstruct your freedom of movement?
Q 234	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you look down to see where the foot pedal is before operating the foot pedal?
Q 235	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Does it annoy you that you have to look down before you can operate the foot pedal?
Q 236	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you sometimes push the wrong switch?
Q 237	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	When I push the wrong switch, this is caused by (multiple options possible).
Q 238	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you wear clogs during laparoscopic surgery?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 239	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you control the foot pedal without shoes?
Q 240	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Why do you control the foot pedal without shoes?
Q 241	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you wear clogs during laparoscopic surgery
Q 242	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Do you control the foot pedal without shoes?
Q 243	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Why do you control the foot pedal without shoes?
Q 244	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	How do you control the foot pedal (multiple options possible)?
Q 245	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Are you satisfied with the use of foot pedals for the operation of the diathermic equipment? Can you indicate why you are not satisfied?
Q 246	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Physical factors	Workstation configuration	Would you rather control the diathermic equipment in a different manner?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 247	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery (Franasiak et al., 2012)	Individual factors	Experience	What year did you finish your residency?
Q 248	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	What year did you finish your Gynecologic Oncology Fellowship?
Q 249	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many years have you been in practice?
Q 250	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	Where do you practice?
Q 251	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	What environment do you practice in?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 252	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	What is your height?
Q 253	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	What is your age?
Q 254	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	What is your gender?
Q 255	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	What is your surgical glove size?
Q 256	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many years has minimally invasive surgery been a part of your practice?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 257	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	What percentage of each type of cases (benign or oncology) do you do? (Total needs to be 100%)
Q 258	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	General demographic characteristics	If you had a preference, how would you choose to post a case?
Q 259	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	Do you perform robotic surgeries?
Q 260	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many robotic cases do you perform a year?
Q 261	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many robotic cases do you perform in a week?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 262	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many robotic cases do you perform in an average day?
Q 263	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How long is your average robotic case?
Q 264	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	What is the average BMI of your robotics cases?
Q 265	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	Which type of robot do you have at your institution (if applicable)?
Q 266	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	How many robots are available?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 267	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	Is the robotic system easily accessed?
Q 268	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	How is access to the robotic system determined?
Q 269	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	How many laparoscopic cases do you perform a year?
Q 270	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many laparoscopic cases do you perform in a week?
Q 271	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How many laparoscopic cases do you perform in an average day?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 272	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Individual factors	Experience	How long is your average laparoscopic case?
Q 273	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	What is the average BMI of your laparoscopic patients?
Q 274	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	Do you have multiple monitors available during laparoscopic surgery?
Q 275	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Workstation configuration	Who typically assists you?
Q 276	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Instruments manipulation	Describe the fit of the laparoscopic surgical instrument in your hand: Bipolar, monopole, needle driver, and grasper.

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 277	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Physical factors	Ergonomics guidelines awareness	Did you receive specific training in ergonomically sound techniques?
Q 278	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Psychosocial factors	Social support	Have you reported your symptoms to your institutions' employee health resources?
Q 279	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive (Esposito et al., 2014)	Individual factors	Experience	How long have you been performing laparoscopy?
Q 280	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	Individual factors	Experience	How many laparoscopic procedure do you perform per week ?
Q 281	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	Individual factors	Experience	How many laparoscopic procedure do you perform per year ?
Q 282	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg? (Vijendren, Yung, Sanchez, & Duffield, 2016)	Individual factors	Experience	What level are you at? (SHO/Core trainee, Sprry/Star, Staff grade/Associate specialist, consultant)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 283	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	Individual factors	Experience	How long have you worked in ENT?
Q 284	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	Individual factors	Experience	What is your subspecialty? (General ENT, Otology, Rhinology, Head& Neck, Laryngology, Base f skull, Pediatrics, Facial Plastics
Q 285	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study(G. I. Lee et al., 2016)	Individual factors	General demographic characteristics	What is your age?
Q 286	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Individual factors	General demographic characteristics	What is your height?
Q 287	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Individual factors	General demographic characteristics	What is your gender?
Q 288	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Individual factors	Experience	What is your specialty?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 289	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Individual factors	Experience	What is the total number of cases you perform per month as a primary surgeon (performing 50 % or more of the procedure)?
Q 290	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Individual factors	Experience	What is the percentage for each type of surgery?
Q 291	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Individual factors	Experience	How many years have you been practicing robotic surgery?
Q 292	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Physical factors	Workstation configuration	Which robotic system do you primarily use for your practice?
Q 293	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Physical factors	Workstation configuration	What type of features does your chair for robotic surgery have? (Please check all that apply)
Q 294	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Physical factors	Workstation configuration	How often do you adjust the ergonomic settings of the surgeon's console?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 295	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Psychosocial factors	Ergonomics guidelines awareness	How confident do you feel that your ergonomic settings are set for the best ergonomics?
Q 296	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Psychosocial factors	Ergonomics guidelines awareness	Do you have your ergonomic settings stored at the surgeon's console?
Q 297	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Psychosocial factors	Ergonomics guidelines awareness	How helpful are the ergonomic features of the surgeon's console for reducing your physical strain?
Q 298	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Psychosocial factors	Social support	Have you experienced any difficulty in microphone/speaker communication with your OR staff when you are sitting at the surgeon's console?
Q 299	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Physical factors	Workstation configuration	Which robotic system components would need more improvement for better ergonomics? (Please check all that apply)
Q 300	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Physical factors	Workstation configuration	Do you take off your shoes when operating pedals of the surgeon's console?

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 301	Physician pain and discomfort during minimally invasive gynecologic cancer surgery (McDonald et al., 2014)	Physical factors	Workstation configuration	How have you attempted to minimize these injuries or conditions? (Multiple responses allowed) Changing instruments Changing postural position Ignoring any injury or condition Taking a break Other
Q 302	Physician pain and discomfort during minimally invasive gynecologic cancer surgery	Physical factors	Workstation configuration	Which of the operating room factors below appear to minimize your physical complaints?(Multiple responses allowed) Display monitor location Instrument design Operating room table set-up Type of display system Other
Q 303	Modified physical discomfort survey (Alqahtani et al., 2016)	Individual factors	General demographic characteristics	which hand is your dominant hand?
Q 304	Modified physical discomfort survey	Individual factors	General demographic characteristics	How long have you worked in your current position?
Q 305	Modified physical discomfort survey	Cognitive factors	Mental demand	How often are you mentally exhausted after work?
Q 306	Modified physical discomfort survey	Physical factors	Physical demand	How often are you physically exhausted after work?
Q 308	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	Experience	Type of surgeon? (Attending ,Fellow ,Resident ,Medical Student)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 309	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	Experience	If fellow what year fellowship? (1st ,2nd ,3rd ,4th)
Q 310	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	Experience	If resident what year resident? (PGY1 ,PGY2 ,PGY3 ,PGY4)
Q 311	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	How old are you?(20-30 ,31-40 ,41-50 ,51-60 ,61-70 ,71-80)
Q 312	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	Gender: (MALE ,FEMALE)?
Q 313	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	What is your race? (CAUCASION ,AFRICAN AMERICAN , ASIAN , HISPANIC , OTHER)
Q 314	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	How many years have you been operating including residency? (<5 ,6-10 ,11-15 ,16-20 ,21+)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 315	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	Are you a general gynecologist or a subspecialist? (GENERALIST ,SUBSPECIALIST,..)
Q 316	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	How many vaginal surgery cases on average do you perform in a month? (<5 ,6-10 ,11-15 ,16-20 ,21+)
Q 317	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhua Zhu	Individual factors	General demographic characteristics	How many vaginal reconstructive surgery cases (TVH, APR, and or vaginal colpopexies) have you performed in your career? (< 10 ,11-20 ,21-50 ,51-100 ,100-500 ,>500)
Q 318	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	General demographic characteristics	How long on average are the shortest vaginal surgeries you perform (in minutes)? (<30 ,31-60 ,61-120 ,121-240 ,241+)
Q 319	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	General demographic characteristics	How long on average are the longest vaginal surgeries you perform (in minutes)? (<30 ,31-60 ,61-120 ,121-240 ,241+)
Q 320	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	Experience	What type of surgery do you perform? (Circle all that apply) (VAGINAL ,LAPAROSCOPIC ,ROBOTIC ,OPEN)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 321	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	Experience	If you perform vaginal surgery, what percentage of your surgeries are vaginal? (0-20% ,21-40% ,41-60% ,61-80% ,81-100%)
Q 322	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	Experience	If you perform laparoscopic surgery, what percentage of your surgeries are laparoscopic? (0-20% ,21-40% ,41-60% ,61-80% ,81-100%)
Q 323	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	Experience	If you perform robotic surgery, what percentage of your surgeries are robotic? (0-20% ,21-40% ,41-60% ,61-80% ,81-100%)
Q 324	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	Experience	If you perform open surgery, what percentage of your surgeries are open? (0-20% ,21-40% ,41-60% ,61-80% ,81-100%)
Q 325	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	General demographic characteristics	What is your dominant hand? (RIGHT ,LEFT ,AMBIDEXTROUS)
Q 326	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	General demographic characteristics	How many hours do you spend performing strenuous physical (raise heart rate >110) activity in a week (in hours)?AT WORK (<1 ,1-7 ,8-15 ,16-30 ,31+ OUTSIDE OF WORK ,<1 ,1-7 ,8-15 ,16-30 ,31+)

Question No.	Tool	Category of risk factor	Risk factor	Question
Q 327	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	Experience	How many hours do you spend operating per week? (1-5 ,6-10 ,11-20 ,>21)
Q 328	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	General demographic characteristics	Do you exercise? (YES ,NO)
Q 329	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Individual factors	General demographic characteristics	How often do you exercise? (DAILY ,EVER OTHER DAY ,2X/WEEK ,ONCE/WEEK)

5.1.2. Comprehensive question pool part II: Outcome measurements

Question No.	Tool	Outcome Measurement Categories	Question
Q 1	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms (Kuorinka et al., 1987b)	MSDs	The date of injury?
Q 2	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	Discomfort/pain/stiffness/fatigue	Have you at any time during the last 12 month had trouble (ache, pain, discomfort, numbness) in: 9 body parts including, neck, shoulder, lower back upper and lower body parts
Q 3	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	Have you ever been hospitalized because of the trouble?
Q 4	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	Have you ever had to change job or duties because of the trouble?
Q 5	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	What is the total length of the trouble that you have had the trouble during the last 12 months?

Question No.	Tool	Outcome Measurement Categories	Question
Q 6	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	Has the trouble caused you to reduce your activity during the last 12 months?
Q 7	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	What is the total length of time that the trouble has prevented you from doing your normal work (at home or away from home) during the last 12 months?
Q 8	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	Have you been seen by a doctor, physiotherapist, chiropractor or other such person because of the trouble during the last 12 months?
Q 9	Standardized Nordic questionnaires for the analysis of musculoskeletal symptoms	MSDs	Have you had the trouble any time during the last 7 days?
Q 10	Version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E) (Roja et al., 2015b)	Discomfort/pain/stiffness/fatigue	Have you at any time during the last 12 month had trouble (ache, pain, discomfort, numbness) in: 9 body parts including, neck, shoulder, lower back upper and lower body parts
Q 11	Version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Discomfort/pain/stiffness/fatigue	Have you had trouble during the last week in: 9 body parts including, neck, shoulder, lower back upper and lower body parts

Question No.	Tool	Outcome Measurement Categories	Question
Q 12	Version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	Discomfort/pain/stiffness/fatigue	Have you had trouble during the last week in: 9 body parts including, neck, shoulder, lower back upper and lower body parts
Q 13	Version of Standardized Nordic Musculoskeletal Questionnaire (NMQ-E)	MSDs	During the last 12 month have you been prevented from carrying out relaxation activities (e.g.. physical activities, housework, hobbies, swimming) because of this trouble: 9 body parts including, neck, shoulder, lower back upper and lower body parts
Q 14	The body part discomfort questionnaire (BPD) (Corlett & Bishop, 1976)	Discomfort/pain/stiffness/fatigue	Mark location of musculoskeletal discomfort. (Neck, shoulders, upper arms, lower arms, upper back, mid back, lower back, buttocks, thighs, legs)
Q 15	The body part discomfort questionnaire (BPD)	Discomfort/pain/stiffness/fatigue	Discomfort level in discomfort location. (1- Extremely comfortable, 5- Extremely uncomfortable)
Q 16	Local experienced discomfort questionnaire (LED) (Corlett & Bishop, 1976)	Discomfort/pain/stiffness/fatigue	For each of body parts indicated by the letter in the picture mark discomfort locations. (Neck, shoulders, upper arms, lower arms, upper back, mid back, lower back, buttocks, thighs, legs)
Q 17	Local experienced discomfort questionnaire (LED)	Discomfort/pain/stiffness/fatigue	For each of body parts indicated by the letter in the picture, please fill in a score as presented. (0- No complaint at al, 1/2-Hardly any complaints, 2- some complaints, 4- Quite a lot complaints, 7- A lot o complaints, 10- Extreme amount of complaints)

Question No.	Tool	Outcome Measurement Categories	Question
Q 18	Workstyle Short Form (Feuerstein & Nicholas, 2006)	Discomfort/pain/stiffness/fatigue	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. My hands and arms feel tired during the workday.
Q 19	Workstyle Short Form	Discomfort/pain/stiffness/fatigue	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. I feel achy when I work at my workstation.(Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 20	Workstyle Short Form	Discomfort/pain/stiffness/fatigue	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. There really isn't much I can do to help myself in terms of eliminating or reducing my symptoms in my hands/arms/shoulders/neck. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 21	Workstyle Short Form	Disability	Rate the degree to which each of the following items describes you at WORK by selecting the appropriate option. My fingers/wrists/hands/arms (any one or combination) make jerky, quick, sudden movements. (Almost never, Rarely, Sometimes, Frequently, Almost always)
Q 22	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire (Berguer, 2014)	Discomfort/pain/stiffness/fatigue	Have you experienced any of the following problems during or following laparoscopic surgery? Stiffness, pain, or numbness in body parts: (Neck, shoulder, Hand/wrist, Back, and legs)

Question No.	Tool	Outcome Measurement Categories	Question
Q 23	Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Ergonomics Questionnaire	Discomfort/pain/stiffness/fatigue	Have you experienced any of the following problems during or following laparoscopic surgery? Eye fatigue(excessive dryness/tearing blurry vision)/ Headache)
Q 24	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH) (Gummesson et al., 2006)	Disability	Please rate your ability to do the following activities in the last week by circling the number below the appropriate response. (NO MILD MODERATE SEVERE DIFFICULTY UNABLE) 1. Open a tight or new jar. 2. Do heavy household chores (e.g., wash walls, floors). 3. Carry a shopping bag or briefcase. 4. Wash your back. 5. Use a knife to cut food. 6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).
Q 25	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH)	Disability	During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbors or groups?
Q 26	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH)	Disability	During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?

Question No.	Tool	Outcome Measurement Categories	Question
Q 27	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH)	Disability	Please rate the severity of the following symptoms in the last week: Tingling (pins and needles) in your arm, shoulder or hand.
Q 28	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH)	Disability	During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand?
Q 29	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH)	Disability	Did you have any difficulty: 1. using your usual technique for your work? 2. doing your usual work because of arm, shoulder or hand pain? 3. doing your work as well as you would like? 4. spending your usual amount of time doing your work?
Q 30	The shortened disabilities of the arm, shoulder and hand questionnaire (Quick DASH)	Disability	Please circle the number that best describes your physical ability in the past week: 1. using your usual technique for playing your instrument or sport? 2. playing your musical instrument or sport because of arm, shoulder or hand pain? 3. playing your musical instrument or sport as well as you would like? 4. spending your usual amount of time practicing or playing your instrument or sport?
Q 31	Physical discomfort survey (G. I. Lee et al., 2016)	Discomfort/pain/stiffness/fatigue	Complete the following Physical Discomfort Survey if you feel discomfort or pain in your body during or after work. For each body part describe how often you experience in/discomfort and how severe it is. (Body parts including, neck, shoulder, lower back upper and lower body parts)

Question No.	Tool	Outcome Measurement Categories	Question
Q 32	Physical discomfort survey	Discomfort/pain/stiffness/fatigue	For each body part describe how often you experience in/discomfort and how severe it is. (parts including, neck, shoulder, lower back upper and lower body parts)
Q 33	Physical discomfort survey	Discomfort/pain/stiffness/fatigue	Briefly describe the conditions you believe relate to your discomfort.
Q 34	Physical discomfort survey	Discomfort/pain/stiffness/fatigue	What suggestions do you have for addressing your concerns?
Q 35	Physical discomfort survey	Discomfort/pain/stiffness/fatigue	Did the pain develop, suddenly or gradually?
Q 36	Physical discomfort survey	Discomfort/pain/stiffness/fatigue	When did you first notice the pain?
Q 37	Physical discomfort survey	Discomfort/pain/stiffness/fatigue	When you felt the pain, were you doing the job the way that you usually do? (Yes / No. If no, what was different?)

Question No.	Tool	Outcome Measurement Categories	Question
Q 38	University of Michigan Upper Extremity Questionnaire (Salerno et al., 2001)	MSDs	Location of injury symptoms? (Neck/shoulder/upper arm, Elbow/forearm, and Wrist/hand/finger)
Q 39	University of Michigan Upper Extremity Questionnaire	MSDs	Duration of episodes of problems
Q 40	University of Michigan Upper Extremity Questionnaire	MSDs	Association of the discomfort with workstation or work activity?
Q 41	University of Michigan Upper Extremity Questionnaire	MSDs	Received treatment?
Q 42	Michigan Hand Outcomes Questionnaire(MHQ) (K. C. Chung, Hamill, Walters, & Hayward, 1999)	Disability	Overall how well did your hand work? (very good 1, good 2,fair 3, poor 4, very poor 5)
Q 43	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	How well did your fingers move?(very good 1, good 2,fair 3, poor 4, very poor 5)

Question No.	Tool	Outcome Measurement Categories	Question
Q 44	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	How well did your wrist move?(very good 1, good 2,fair 3, poor 4, very poor 5)
Q 45	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	How was the strength in your hand?(very good 1, good 2,fair 3, poor 4, very poor 5)
Q 46	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	How was the sensation (feeling) in your hand?(very good 1, good 2,fair 3, poor 4, very poor 5)
Q 47	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	<p>Activities of daily living for 1 hand (worded for left or right): The following questions refer to the ability of your hand(s) to do certain tasks during the past week. How difficult was it for you to perform the following activities using your hand? (not at all difficult 1,a little difficult 2, somewhat difficult 3, moderately difficult 4, very difficult 5)</p> <ol style="list-style-type: none"> 1. Turn a door knob. 2. Pick up a coin 3. Hold a glass of water. 4. Turn a key in the lock. 5. Hold a frying pan.

Question No.	Tool	Outcome Measurement Categories	Question
Q 48	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	<p>Activities of daily living using both hands: How difficult was it for you to perform the following activities using both of your hands? (not at all difficult 1, a little difficult 2, somewhat difficult 3, moderately difficult 4, very difficult 5)</p> <ol style="list-style-type: none"> 1. Open a jar. 2. Button a shirt or blouse 3. Eat with a knife and fork. 4. Carry a grocery bag. 5. Wash dishes. 6. Wash your hair. 7. Tie shoelaces or knots
Q 49	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	<p>Normal work: The following questions refer to how you did in your normal work (including both housework and school work) during the past 4 weeks. (always 1, often 2, sometimes 3, rarely 4, never 5)</p> <ol style="list-style-type: none"> 1. How often were you unable to do your work because of problems with your hand(s) and/or wrist(s)? 2. How often did you have to shorten your work day because of problems with your hand(s)? 3. How often did you have to take it easy at your work because of problems with your hand(s) or wrist(s)? 4. How often did you accomplish less in your work because of problems with your hand(s) or wrist(s)? 5. How often did you awake longer to do the tasks in your work because of problems with your hand(s) or wrist(s)?
Q 50	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	<p>Pain: The following questions refer to how much pain you had in your hand(s) and/or wrist(s) during the past week. (Response for 1 3 4 & 5 Points: always 1, often 2, sometimes 3, rarely 4, never 5, Response for 2 Points: very mild 5 mild 4, moderate 3, severe 2, very severe 1)</p> <ol style="list-style-type: none"> 1. How often did you have pain in your hand(s) and/or wrists(s)? 2. Please describe the pain you have in your hand(s) and/or wrists(s)?

Question No.	Tool	Outcome Measurement Categories	Question
			<p>3. How often did the pain in your hand(s) and/or wrists(s) interfere with your sleep?</p> <p>4. How often did the pain in your hand(s) and/or wrists(s) interfere with your daily activities (such as eating or bathing)?</p> <p>5. How often did the pain in your hand(s) and/or wrists(s) make you unhappy?</p>
Q 51	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	<p>Recoding for pain: values question 2 are reversed</p> <p>Appearance (looks): The following questions refer to the appearance (look) of your hand during the past week.</p> <p>1. I was satisfied with the appearance (look) of my hand.</p> <p>2. The appearance (look) of my hand sometimes made me uncomfortable in public.</p> <p>3. The appearance (look) of my hand made me depressed.</p> <p>4. The appearance (look) of my hand interfered with my normal social activities.</p>
Q 52	Michigan Hand Outcomes Questionnaire(MHQ)	Disability	<p>Satisfaction: The following questions refer to your satisfaction with your hand/wrist during the past week.</p> <p>1. Overall function of your hand?</p> <p>2. Motion of the fingers in your hand?</p> <p>3. Motion of your wrist?</p> <p>4. Strength level of your hand?</p> <p>5. Pain level of your hand?</p> <p>6. Sensation (feeling) of your hand?</p>
Q 53	The Oswestry Disability Index (Fairbank & Pynsent, 2000)	Discomfort/pain/stiffness/fatigue	<p>Please just mark the box which most closely describes your problem.</p> <p>I can tolerate the pain I have without having to use painkillers.</p> <p>The pain is bad but I manage without taking painkillers.</p> <p>Painkillers give complete relief from pain.</p> <p>Painkillers give moderate relief from pain.</p> <p>Painkillers give very little relief from pain.</p> <p>Painkillers have no effect on the pain and I do not use them.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 54	The Oswestry Disability Index	Discomfort/pain/stiffness/fatigue	Please just mark the box which most closely describes your problem. I have no pain at the moment. The pain is very mild at the moment. The pain is moderate at the moment. The pain is fairly severe at the moment. The pain is very severe at the moment. The pain is the worst imaginable at the moment.
Q 55	The Oswestry Disability Index	Discomfort/pain/stiffness/fatigue	Please just mark the box which most closely describes your problem. The pain comes and goes and is very mild. The pain is mild and does not vary much. The pain comes and goes and is moderate. The pain is moderate and does not vary much. The pain comes and goes and is severe. The pain is severe and does not vary much.
Q 56	The Oswestry Disability Index	Disability	Please just mark the box which most closely describes your problem. I can look after myself normally without causing extra pain. I can look after myself normally but it causes extra pain. It is painful to look after myself and I am slow and careful. I need some help but manage most of my personal care. I need help every day in most aspects of self-care. I do not get dressed, wash with difficulty and stay in bed.
Q 57	The Oswestry Disability Index	Disability	Please just mark the box which most closely describes your problem. I can look after myself normally without causing extra pain. I can look after myself normally but it is very painful. It is painful to look after myself and I am slow and careful. I need some help but manage most of my personal care. I need help every day in most aspects of self care. I do not get dressed, wash with difficulty and stay in bed.

Question No.	Tool	Outcome Measurement Categories	Question
Q 58	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can dress myself without pain.</p> <p>I can dress myself without increasing pain.</p> <p>I can dress myself but pain increases.</p> <p>I can dress myself but with significant pain.</p> <p>I can dress myself but with very severe pain.</p> <p>I cannot dress myself.</p>
Q 59	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I would not have to change my way of washing or dressing in order to avoid pain.</p> <p>I do not normally change my way of washing or dressing even though it causes some pain.</p> <p>Washing and dressing increase the pain but I manage not to change my way of doing it.</p> <p>Washing and dressing increase the pain and I find it necessary to change my way of doing it.</p> <p>Because of the pain I am unable to do some washing and dressing without help.</p> <p>Because of the pain I am unable to do any washing and dressing without help.</p>
Q 60	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can lift heavy weights without extra pain.</p> <p>I can lift heavy weights but it gives extra pain.</p> <p>Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, e.g. on a table.</p> <p>Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.</p> <p>I can lift only very light weights.</p> <p>I cannot lift or carry anything at all.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 61	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can lift heavy weights without extra pain.</p> <p>I can lift heavy weights but it gives extra pain.</p> <p>Pain prevents me from lifting heavy weights off the floor but I can manage if they are conveniently positioned, e.g. on a table.</p> <p>Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.</p> <p>I can lift only very light weights.</p> <p>I cannot lift or carry anything at all.</p>
Q 62	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can lift heavy objects without pain.</p> <p>I can lift heavy objects but it is painful.</p> <p>Pain prevents me from lifting heavy objects off the floor, but I can lift heavy objects if they are on a table.</p> <p>Pain prevents me from lifting heavy objects, but I can lift light to medium objects if they are on a table.</p> <p>I can only lift light objects.</p> <p>I cannot lift anything.</p>
Q 63	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can lift heavy weights without extra pain.</p> <p>I can lift heavy weights but it gives extra pain.</p> <p>Pain prevents me from lifting heavy weights off the floor.</p> <p>Pain prevents me from lifting heavy weights off the floor but I can manage if they are conveniently positioned, e.g. on a table.</p> <p>Pain prevents me from lifting heavy weights but I can manage light to medium weights if they are conveniently positioned.</p> <p>I can only lift very light weights at the most.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 64	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>Pain does not prevent my walking any distance.</p> <p>Pain prevents me walking more than 1 mile.</p> <p>Pain prevents me walking more than 1/2 mile.</p> <p>Pain prevents me walking more than 1/4 mile.</p> <p>I can only walk using a stick or crutches.</p> <p>I am in bed most of the time and have to crawl to the toilet.</p>
Q 65	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>Pain does not prevent me walking any distance.</p> <p>Pain prevents me walking more than 1 mile.</p> <p>Pain prevents me walking more than 1/2 of a mile.</p> <p>Pain prevents me walking more than 100 yards.</p> <p>I can only walk using a stick or crutches.</p> <p>I am in bed most of the time and have to crawl to the toilet.</p>
Q 66	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can run or walk without pain.</p> <p>I can walk comfortably, but running is painful.</p> <p>Pain prevents me from walking more than 1 hour.</p> <p>Pain prevents me from walking more than 30 minutes.</p> <p>Pain prevents me from walking more than 10 minutes.</p> <p>I am unable to walk or can walk only a few steps at a time.</p>
Q 67	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I have no pain on walking.</p> <p>I have some pain with walking but it does not increase with distance.</p> <p>I cannot walk more than One Mile without increasing pain.</p> <p>I cannot walk more than 1/2 Mile without increasing pain.</p> <p>I cannot walk more than 1/4 Mile without increasing pain.</p> <p>I cannot walk at all without increasing pain.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 68	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can sit in any chair as long as I like.</p> <p>I can sit in my favorite chair as long as I like.</p> <p>Pain prevents me sitting more than 1 hour.</p> <p>Pain prevents me from sitting more than 1/2 an hour.</p> <p>Pain prevents me from sitting more than 10 minutes.</p> <p>Pain prevents me from sitting at all.</p>
Q 69	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can sit in any chair as long as I like.</p> <p>I can sit in my favorite chair as long as I like.</p> <p>Pain prevents me from sitting for more than 1 hour.</p> <p>Pain prevents me from sitting for more than 1/2 an hour.</p> <p>Pain prevents me from sitting for more than 10 minutes.</p> <p>Pain prevents me from sitting at all.</p>
Q 70	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can sit in any chair as long as I like.</p> <p>I can only sit in a special chair as long as I like.</p> <p>Pain prevents me from sitting more than 1 hour.</p> <p>Pain prevents me from sitting more than 30 minutes.</p> <p>Pain prevents me from sitting more than 10 minutes.</p> <p>Pain prevents me from sitting at all.</p>
Q 71	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can sit in any chair as long as I like.</p> <p>I can sit only in my favorite chair as long as I like.</p> <p>Pain prevents me from sitting for more than one hour.</p> <p>Pain prevents me from sitting for more than 1/2 hour.</p> <p>Pain prevents me from sitting for more than 10 minutes.</p> <p>I avoid sitting because it increases pain straight away.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 72	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can stand as long as I want without extra pain.</p> <p>I can stand as long as I want but it gives me extra pain.</p> <p>Pain prevents me from standing for more than 1 hour.</p> <p>Pain prevents me from standing for more than 30 minutes.</p> <p>Pain prevents me from standing for more than 10 minutes.</p> <p>Pain prevents me from standing at all.</p>
Q 73	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can stand as long as I want without extra pain.</p> <p>I can stand as long as I want but it gives me extra pain.</p> <p>Pain prevents me from standing for more than 1 hour.</p> <p>Pain prevents me from standing for more than 1/2 an hour.</p> <p>Pain prevents me from standing for more than 10 minutes.</p> <p>Pain prevents me from standing at all.</p>
Q 74	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can stand as long as I want.</p> <p>I can stand as long as I want but it gives me pain.</p> <p>Pain prevents me from standing more than 1 hour.</p> <p>Pain prevents me from standing for more than 30 minutes.</p> <p>Pain prevents me from standing for more than 10 minutes.</p> <p>Pain prevents me from standing at all.</p>
Q 75	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I can stand as long as I want without pain.</p> <p>I have some pain on standing but it does not increase with time.</p> <p>I cannot stand for longer than one hour without increasing pain.</p> <p>I cannot stand for longer than 1/2 hour without increasing pain.</p> <p>I cannot stand for longer than 10 minutes without increasing pain.</p> <p>I avoid standing because it increases pain straight away.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 76	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>Pain does not prevent me from sleeping well.</p> <p>I can sleep well only by using tablets.</p> <p>Even when I take tablets I have less than 6 hours sleep.</p> <p>Even when I take tablets I have less than 4 hours sleep.</p> <p>Even when I take tablets I have less than 2 hours sleep.</p> <p>Pain prevents me from sleeping at all.</p>
Q 77	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>My sleep is never disturbed by pain.</p> <p>My sleep is occasionally disturbed by pain.</p> <p>Because of pain I have less than 6 hours sleep.</p> <p>Because of pain I have less than 4 hours sleep.</p> <p>Because of pain I have less than 2 hours sleep.</p> <p>Pain prevents me from sleeping at all.</p> <p>51. Sleeping (in the past week).</p>
Q 78	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I sleep well.</p> <p>Pain occasionally interrupts my sleep.</p> <p>Pain interrupts my sleep half of the time.</p> <p>Pain often interrupts my sleep.</p> <p>Pain always interrupt</p>
Q 79	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>I get no pain in bed.</p> <p>I get pain in bed but it does not prevent me from sleeping well.</p> <p>Because of pain my normal nights sleep is reduced by less than 1/4.</p> <p>Because of pain my normal nights sleep is reduced by less than 1/2.</p> <p>Because of pain my normal nights sleep is reduced by less than 3/4.</p> <p>Pain prevents (me) from sleeping at all.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 80	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>My sex life is normal and causes no extra pain.</p> <p>My sex life is normal but causes some extra pain.</p> <p>My sex life is nearly normal but is very painful.</p> <p>My sex life is severely restricted by pain.</p> <p>My sex life is nearly absent because of pain.</p> <p>Pain prevents any sex life at all.</p>
Q 81	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>My sex life is normal and causes no extra pain.</p> <p>My sex life is normal but causes some extra pain.</p> <p>My sex life is nearly normal but is very painful.</p> <p>My sex life is severely restricted by pain.</p> <p>My sex life is nearly absent because of pain.</p> <p>Pain prevents any sex life at all.</p>
Q 82	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>My social life is normal and causes me no extra pain.</p> <p>My social life is normal but increases the degree of pain.</p> <p>Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g. sport, etc.</p> <p>Pain has restricted my social life and I do not go out as often.</p> <p>Pain has restricted social life to my home.</p> <p>I have no social life because of pain.</p>
Q 83	The Oswestry Disability Index	Disability	<p>Please just mark the box which most closely describes your problem.</p> <p>My social life is normal and causes me no extra pain.</p> <p>My social life is normal but increases the degree of pain.</p> <p>Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g. sport, etc.</p> <p>Pain has restricted my social life and I do not go out as often.</p> <p>Pain has restricted social life to my home.</p> <p>I have no social life because of pain.</p>

Question No.	Tool	Outcome Measurement Categories	Question
Q 84	The Oswestry Disability Index	Disability	Please just mark the box which most closely describes your problem. My social life is normal and gives me no pain. My social life is normal but increases the degree of my pain. Pain has no significant effect on my social life apart from limiting my more energetic interests, e.g. dancing, etc. Pain has restricted my social life and I do not go out very often. Pain has restricted social life to my home.
Q 85	Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) (Hedge et al., 1999)	Discomfort/pain/stiffness/fatigue	Mark location (including neck, upper and lower body parts) of musculoskeletal discomfort, ache, pain during last week)
Q 86	Cornell Musculoskeletal Discomfort Questionnaires (CMDQ)	Discomfort/pain/stiffness/fatigue	during the last work week how often did you experience ache, pain, discomfort?
Q 87	Cornell Musculoskeletal Discomfort Questionnaires (CMDQ)	Discomfort/pain/stiffness/fatigue	if you experienced ache, pain, discomfort, how uncomfortable was this?
Q 88	Cornell Musculoskeletal Discomfort Questionnaires (CMDQ)	Discomfort/pain/stiffness/fatigue	if you experienced ache, pain, discomfort, did this interfere with your ability to work?

Question No.	Tool	Outcome Measurement Categories	Question
Q 89	Application of ergonomic guidelines during minimally invasive surgery: a questionnaire survey of 284 surgeons (Wauben, Veelen, et al., 2006)	Discomfort/pain/stiffness/fatigue	Rate your physical discomfort, from 0 (no pain) to 5 (severe pain), in the different body areas.
Q 90	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance (Santos-Carreras et al., 2012)	Discomfort/pain/stiffness/fatigue	Have you ever experienced abnormal amount of pain or discomfort in any of the following areas? While performing open surgery:(neck/ shoulders/ back/wrist/fingers)
Q 91	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Discomfort/pain/stiffness/fatigue	Have you ever experienced abnormal amount of pain or discomfort in any of the following areas? While performing laparoscopic surgery: (neck/ shoulders/ back/ wrists/ fingers)
Q 92	Survey on Surgical Instrument Handle Design Ergonomics and Acceptance	Discomfort/pain/stiffness/fatigue	Have you ever experienced abnormal amount of pain or discomfort in any of the following areas? While performing robotic surgery:(neck/ shoulders/ back/ wrists/ fingers)
Q 93	FESS, fingers and other things--you are not alone! (Amin et al., 2015)	Discomfort/pain/stiffness/fatigue	Do you or have you experienced any of these symptoms that you can attribute to the use of endoscopy or your body posture during ESS procedures? If so please indicate the type of symptoms: Pain <input type="checkbox"/> Stiffness <input type="checkbox"/> Paraneesthesia <input type="checkbox"/> None <input type="checkbox"/>
Q 94	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	If you have experienced any of these symptoms that you can attribute to the use of endoscopy or your body posture during ESS, which area of your body was affected? (Tick as appropriate) Neck <input type="checkbox"/> Head <input type="checkbox"/> Shoulders <input type="checkbox"/> Elbows <input type="checkbox"/> Wrists <input type="checkbox"/> Thumbs <input type="checkbox"/>

Question No.	Tool	Outcome Measurement Categories	Question
			Fingers <input type="checkbox"/> Back <input type="checkbox"/> Hips <input type="checkbox"/> Knees <input type="checkbox"/> Ankles <input type="checkbox"/> Feet <input type="checkbox"/>
Q 95	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	Is the affected area of your body (Tick as appropriate) On the side which you hold the endoscope <input type="checkbox"/> On the side where you hold the surgical instruments <input type="checkbox"/>
Q 96	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	How long have you suffered with your current symptoms? 1-6 months <input type="checkbox"/> 1-5 years <input type="checkbox"/> 5-10 years <input type="checkbox"/> more than 10 years <input type="checkbox"/>
Q 97	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	How would you rate the severity of your symptoms? Please circle one (10 being the worst pain). 1 2 3 4 5 6 7 8 9 10
Q 98	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	Have your symptoms interfered with your hobbies, recreational or social activities? Yes <input type="checkbox"/> No <input type="checkbox"/>
Q 99	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	Have you required time off work because of the severity of your symptoms? Yes <input type="checkbox"/> No <input type="checkbox"/>

Question No.	Tool	Outcome Measurement Categories	Question
Q 100	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	Have you had a specific problem diagnosed such as prolapsed disk ? Yes <input type="checkbox"/> No <input type="checkbox"/>
Q 101	FESS, fingers and other things--you are not alone!	Discomfort/pain/stiffness/fatigue	Have you any comments or advice for new ESS surgeons to avoid/minimize these potential occupational hazards.
Q 102	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions (Davis et al., 2014)	MSDs	What area was injured in your most recent injury? (Neck, back/spine, shoulder/elbow, hand, Hip/Knee, Foot/ankle, other)
Q 103	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	On a scale of 1-10, how severe was the pain from your most recent injury?(1= Least severe, 10=most severe)
Q 104	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	How long did the pain from your most recent injury last? (1-6 days, 1-4 weeks, 1-3 months,4-11 months, >1 year)
Q 105	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	How would you characterize the cause of your most recent injury? (Acute(sharps injury, fall, etc.), Chronic(strain from headlamp, operation posture,etc), Other)

Question No.	Tool	Outcome Measurement Categories	Question
Q 106	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	Did you receive medical care as a result of your most recent injury? (Yes, No)
Q 107	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	Did you report your most recent injury to your institution? (Yes, No)
Q 108	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	Did your most recent injury force you to stop operation permanently? (Yes, No)
Q 109	Musculoskeletal occupational injury among surgeons: effects for patients, providers, and institutions	MSDs	Did your most recent injury impact your performance in the operating room? (No impact on performance, Minimal impact on performance, Moderate impact on performance, Severe impact on performance,)
Q 110	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members (Cavanagh et al., 2012b)	Discomfort/pain/stiffness/fatigue	Have you ever had any discomfort or physical symptoms that you would attribute to your surgical practice? (Please circle) Yes or No If you answered yes, which of the following apply? (Please circle) Numbness Stiffness Fatigue Pain

Question No.	Tool	Outcome Measurement Categories	Question
Q 111	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	Which body part(s) has been affected?
Q 112	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	Are these symptoms localized or radiating?
Q 113	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	Please describe any other injuries or conditions that were not listed above that you would attribute to your surgical practice. If you answered yes, which of the following apply? (Please circle) Numbness Stiffness Fatigue Pain
Q 114	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	Have you ever received therapy or treatment for the injuries or conditions? (Please circle) Yes or No a. If yes, has this therapy improved the condition? b. If yes, has this condition been remedied?
Q 115	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	When do these symptoms or discomforts affect you the most?

Question No.	Tool	Outcome Measurement Categories	Question
Q 116	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	How have you attempted to minimize these problems?
Q 117	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	Have you ever required surgery for your injury or condition? If so, what was the outcome?
Q 118	Work environment discomfort and injury: an ergonomic survey study of the American Society of Pediatric Otolaryngology members	Discomfort/pain/stiffness/fatigue	Does this limit your practice? a. If yes, what procedure is most difficult to perform? b. If yes, is it still problematic?
Q 119	Patients Benefit While Surgeons Suffer: An Impending Epidemic (A. Park et al., 2010)	Discomfort/pain/stiffness/fatigue	Have you ever had any physical discomfort or symptoms you would attribute to your laparoscopic operating?
Q 120	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Discomfort/pain/stiffness/fatigue	If you answered yes to question 8, which of the following apply? (numbness, stiffness, fatigue, pain, and history of treatment received for each individual body part†)
Q 121	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Discomfort/pain/stiffness/fatigue	Please describe any other injuries or conditions that were not included above.

Question No.	Tool	Outcome Measurement Categories	Question
Q 122	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Discomfort/pain/stiffness/fatigue	When do these symptoms or discomforts bother you?
Q 123	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Discomfort/pain/stiffness/fatigue	How have you attempted to minimize these problems or conditions?
Q 124	Patients Benefit While Surgeons Suffer: An Impending Epidemic	Discomfort/pain/stiffness/fatigue	Which of these factors do you attribute your physical complaints?
Q 125	Comparison of Neuromuscular Injuries to the Surgeon during Hand-Assisted and Standard Laparoscopic Urologic Surgery (W. K. Johnston et al., 2005)	Discomfort/pain/stiffness/fatigue	Hand-assisted laparoscopy: How often do you Neck/upper back. Lower back , hand/wrist, forearm/elbow, shoulder pain?(usually, frequently, occasionally, rare, never)
Q 126	Comparison of Neuromuscular Injuries to the Surgeon during Hand-Assisted and Standard Laparoscopic Urologic Surgery	Discomfort/pain/stiffness/fatigue	Standard laparoscopy: How often do you Neck/upper back. Lower back , hand/wrist, forearm/elbow, shoulder pain?(usually, frequently, occasionally, rare, never)
Q 127	Ergonomics and Design of Laparoscopic Instruments: Results of a Survey among laparoscopic surgeons (Van Veelen & Meijer, 1999)	Discomfort/pain/stiffness/fatigue	Do you experience any discomfort with the interaction while using the present instruments?

Question No.	Tool	Outcome Measurement Categories	Question
Q 128	Ergonomics and Design of Laparoscopic Instruments: Results of a Survey among laparoscopic surgeons	Discomfort/pain/stiffness/fatigue	Do you experience any physical discomfort while using the instruments?
Q 129	Articulating vs. conventional laparoscopic grasping tools—surgeons' opinions (Trejo et al., 2006)	Discomfort/pain/stiffness/fatigue	Do you normally experience any of the following problem during or following laparoscopic surgery?(No, slight, substantial) (Neck, shoulder/arm, hand/wrist, back) pain (Neck, shoulder/arm, hand/wrist, back) stiffness headache
Q 130	Articulating vs. conventional laparoscopic grasping tools—surgeons' opinions	Discomfort/pain/stiffness/fatigue	Do you normally experience any of the following problem during or following laparoscopic surgery?(No, slight, substantial) Mental fatigue irritability exhaustion excessive tachycardia/sweating/tremors
Q 131	Improved usability of a new handle design for laparoscopic dissection forceps (Veelen et al., 2002)	Discomfort/pain/stiffness/fatigue	Regarding the position of the handle in relation to the shaft (angle between handle and shaft), what is the experience of comfort/discomfort during use?
Q 132	Improved usability of a new handle design for laparoscopic dissection forceps	Discomfort/pain/stiffness/fatigue	Regarding the way of opening and closing the instrument tip (flexion/extension fingers, spring use), what is the experience of comfort/discomfort during use?

Question No.	Tool	Outcome Measurement Categories	Question
Q 133	Improved usability of a new handle design for laparoscopic dissection forceps	Discomfort/pain/stiffness/fatigue	Regarding the pressure of the handle on your hand (fingers), what is the experience of comfort/discomfort during use?
Q 134	Improved usability of a new handle design for laparoscopic dissection forceps	Discomfort/pain/stiffness/fatigue	Regarding the rotation of the instrument tip, what is the experience of comfort/discomfort during use?
Q 135	MIS instruments	Discomfort/pain/stiffness/fatigue	How comfortable is the handle in your hand?
Q 136	An improved musculoskeletal discomfort assessment tool	Discomfort/pain/stiffness/fatigue	On a Body Map mark: Discomfort frequency? (Never, rarely, frequently, constantly)
Q 137	An improved musculoskeletal discomfort assessment tool	Discomfort/pain/stiffness/fatigue	On a Body Map mark: Discomfort level? (No, fairly, moderate, very uncomfortable, extreme discomfort)
Q 138	An improved musculoskeletal discomfort assessment tool	Discomfort/pain/stiffness/fatigue	On a Body Map mark: Mark discomfort location? (eyes, neck, lower and upper body right/left)

Question No.	Tool	Outcome Measurement Categories	Question
Q 139	A Technique for Assessing Postural Discomfort	Discomfort/pain/stiffness/fatigue	On a Body regions picture: Discomfort level? (seven-point discomfort severity scale ranging from "extremely comfortable" to "extremely uncomfortable".)
Q 140	A Technique for Assessing Postural Discomfort	Discomfort/pain/stiffness/fatigue	On a Body Map mark: Mark discomfort location? (12 regions neck, lower and upper body right/left)
Q 141	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Discomfort/pain/stiffness/fatigue	Do you experience discomfort in legs and/or feet at the end of the day?
Q 142	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Discomfort/pain/stiffness/fatigue	Do you stand during surgery?
Q 143	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Discomfort/pain/stiffness/fatigue	Do you think there is a relationship between the discomfort in legs and/or feet and the fact that you stand a lot during the day?
Q 144	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Discomfort/pain/stiffness/fatigue	Can you indicate the exact place of the discomfort?

Question No.	Tool	Outcome Measurement Categories	Question
Q 145	Improvement of foot pedals used during surgery based on new ergonomic guidelines	Discomfort/pain/stiffness/fatigue	Do you find the use of the commonly used foot pedals comfortable?
Q 146	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	Have you experienced physical discomfort directly related to MIS?
Q 147	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	How would you describe this discomfort
Q 148	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	Where to you experience symptoms? Check all that apply
Q 149	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	How do you attempt to minimize these symptoms?
Q 150	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	Are your symptoms limited only to time spent operating or do they persist?

Question No.	Tool	Outcome Measurement Categories	Question
Q 151	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	Have you seen a professional (PT, orthopedist, primary care) for your symptoms?
Q 152	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	Have you had treatment for physical strain?
Q 153	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	What treatment have you had? Check all that apply.
Q 154	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	Has this injury caused you to limit your practice?
Q 155	Physical strain and urgent need for ergonomic training among gynecologic oncologists who perform minimally invasive surgery	Discomfort/pain/stiffness/fatigue	If yes, how has it limited your practice?
Q 156	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Do you suffer from musculoskeletal disorders after laparoscopy? Where they are located?

Question No.	Tool	Outcome Measurement Categories	Question
Q 157	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	How long have you been suffering from illness? Do they arrive after each lap procedure or only after long procedure? Do you suffer also at home?
Q 158	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Do you sleep well?
Q 159	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Do you use painkillers for this problem? How many times per week? Other therapies?
Q 160	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Do you think that this pain is linked to your laparoscopic activity?
Q 161	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Does this pain influence negatively your surgeon activity?
Q 162	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Does this pain influence negatively your social activity?

Question No.	Tool	Outcome Measurement Categories	Question
Q 163	Work-related upper limb musculoskeletal disorders in pediatric minimally invasive	MSDs	Do you think that laparoscopy has a bad ergonomics for surgeons compared with open surgery?
Q 164	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	MSDs	Do you feel you may have suffered from any musculoskeletal injuries that has been a direct consequence of your job or workplace environment? (if YES questions 2-5, if NO go to demographics section)
Q 165	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	Discomfort/pain/stiffness/fatigue	Do you feel you may have suffered from any musculoskeletal pain that has been a direct consequence of your job or workplace environment? (if YES questions 2-5, if NO go to demographics section)
Q 166	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	MSDs	which body parts have been affected by work-related musculoskeletal pain? (Neck, back , hand, leg)
Q 167	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	MSDs	Has this resulted in an early retirement?
Q 168	Occupational musculoskeletal pain amongst ENT surgeons - are we looking at the tip of an iceberg?	Discomfort/pain/stiffness/fatigue	What type of treatment have you had for this pain?(you may tick more than one) (No treatment, simple analgesia, physiotherapy, Osteopathy, chiropractic, Surgery)

Question No.	Tool	Outcome Measurement Categories	Question
Q 169	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Discomfort/pain/stiffness/fatigue	Have you ever had any physical discomfort or symptoms you would specifically attribute to your robotic operating?
Q 170	Surgeons' physical discomfort and symptoms during robotic surgery: a comprehensive ergonomic survey study	Discomfort/pain/stiffness/fatigue	When do these symptoms bother you? How have you attempted to minimize these problems?
Q 171	Physician pain and discomfort during minimally invasive gynecologic cancer surgery	Discomfort/pain/stiffness/fatigue	Have you had any physical discomfort or symptoms you would attribute to laparoscopic operating? Single response Yes No
Q 172	Physician pain and discomfort during minimally invasive gynecologic cancer surgery	Discomfort/pain/stiffness/fatigue	If you HAVE HAD physical discomfort attributed to your laparoscopic operating, indicate below your symptoms. Multiple responses allowed Numbness Stiffness Fatigue Pain
Q 173	Physician pain and discomfort during minimally invasive gynecologic cancer surgery	Discomfort/pain/stiffness/fatigue	History of treatment received for individual body parts?

Question No.	Tool	Outcome Measurement Categories	Question
Q 174	Physician pain and discomfort during minimally invasive gynecologic cancer surgery	Discomfort/pain/stiffness/fatigue	Describe any other injuries or conditions that are not included in previous question.
Q 175	Physician pain and discomfort during minimally invasive gynecologic cancer surgery	Discomfort/pain/stiffness/fatigue	When do you experience the symptoms or discomforts noted? Single response While performing surgery, immediately after, and persistently While performing surgery, immediately after, but not persistently While performing surgery, immediately after, but not persistently While performing surgery, not immediately after, still persistently Only when performing surgery Not while performing surgery, but immediately after and persistently Other
Q 176	Modified physical discomfort survey	Discomfort/pain/stiffness/fatigue	Have you ever had any pain or discomfort during the last year that you believe is related to your work?
Q 177	Modified physical discomfort survey	Discomfort/pain/stiffness/fatigue	Body part with discomfort?
Q 178	Modified physical discomfort survey	Discomfort/pain/stiffness/fatigue	Severity of discomfort for each of body part?

Question No.	Tool	Outcome Measurement Categories	Question
Q 179	Modified physical discomfort survey	Discomfort/pain/stiffness/fatigue	For each of body part in the boxes(inclosing upper and lower body part: Whether the pain interface with your ability to do your job
Q 180	Modified physical discomfort survey	Discomfort/pain/stiffness/fatigue	For each of body part in the boxes(inclosing upper and lower body part: How often you have discomfort in each body part?
Q 181	Modified physical discomfort survey	Discomfort/pain/stiffness/fatigue	For each of body part in the boxes(inclosing upper and lower body part: on which side of your body the discomfort is felt?
Q 182	Modified physical discomfort survey	MSDs	Previous injury? On which body part?
Q 183	Modified physical discomfort survey	MSDs	Possible cause of injury?
Q 184	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Do you have a history of back injury? ,YES ,NO

Question No.	Tool	Outcome Measurement Categories	Question
Q 185	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Where is your back injury located? (Circle all that apply) (CERVICAL ,THORACIC ,LUMBAR)
Q 186	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Do you currently have a back injury? (YES ,NO)
Q 187	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Where is your current back injury located? (Circle all that apply) (CERVICAL ,THORACIC , LUMBAR)
Q 188	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Have you ever had predisposing musculoskeletal injury (formally diagnosed by physician)?(YES ,NO) If yes, is this musculoskeletal injury still present?,YES ,No
Q 189	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Which type of injury do you have (Select all applicable answers)? Wrist tendonitis / tenosynovitis Carpal tunnel syndrome Tennis Elbow Prolapsed / herniated disc Rotator cuff injury ACL/ meniscus tear / knee injury Other: _____

Question No.	Tool	Outcome Measurement Categories	Question
Q 190	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	MSDs	Do you currently or ever had any of the following medical problems (circle all that apply)? Chronic pain Fibromyalgia Depression Diabetes Spinal stenosis Rotator Cuff Injury Carpel Tunnel Arthritis (Rheumatoid, Osteoarthritis) Other_____
Q 191	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	Do you use a pain reliever for chronic pain? (YES ,NO) If yes, which type of pain reliever do you use?(NSAIDS (Motrin/Advil) ,Tylenol ,Narcotics ,Muscle relaxants (i.e. Baclofen))
Q 192	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	how often do you use medication? Daily Weel;y Monthly Less than once every 6 months Less than once every year
Q 193	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	Do you use any other forms of treatment for pain?(Heating Pad ,Massage ,Stretching Exercises)

Question No.	Tool	Outcome Measurement Categories	Question
Q 194	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	Have you ever had physical therapy before? (YES ,NO)
Q 195	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	Are you currently in physical therapy? (YES ,NO)
Q 196	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	How many hours do you have physical therapy a week? (0-5 ,6-10 ,11-20 ,>21+)
Q 197	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	Do you use pain medications after you exercise? (YES ,NO)
Q 198	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	What type of medication do you use?(NSAIDS (Motrin/Advil) ,Tylenol ,Narcotics ,Muscle relaxants (i.e. Baclofen))
Q 199	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	Do you use pain medications after you operate? (YES ,NO)

Question No.	Tool	Outcome Measurement Categories	Question
Q 200	Workload as a pre-cursor to musculoskeletal strain among vaginal surgeons_ A dissertation submitted by Xinhui Zhu	Discomfort/pain/stiffness/fatigue	What type of medication do you use? (NSAIDS (Motrin/Advil) ,Tylenol ,Narcotics ,Muscle relaxants (i.e. Baclofen))

5.2. APPENDIX 2: Prevalence of Musculoskeletal Disorders among Surgeons Survey

The purpose of this study is investigating the risk of developing work-related musculoskeletal disorders (WRMSDs) among surgeons with diverse backgrounds. This study is conducted by a student for the completion for their thesis. You will be asked to fill out a survey which includes questions in the following categories:

- Demographic characteristics
- Work experience
- History of WRMSDs
- Risk factors associated with the development of WRMSDs in OR

The data collected in this study will be used to evaluate the associations between risk factors and the prevalence of surgeons' WRMSDs and to assist in developing ergonomic interventions to reduce of the risk of developing of WRMSDs among surgeons.

Your participation in this study is **anonymous** and **voluntary**. The number of questions that you will respond to will vary between **23** and **125** based on your experience in performing surgery. As a way to thank you for your participation, individuals who complete the survey can enter into a random drawing to **win one of five \$100 Amazon gift cards**. If you are interested in participating in the lottery, you will be instructed to submit your contact information after submitting your survey. I will only use the information to contact you if you won the lottery. There will be **no link** between your answers and your contact information.

If you have any questions about this research project, please contact the Principle Investigator Dr. Xinhui Zhu (zhuxin@oregonstate.edu) or Student Researcher Kiana Kia (kiak@oregonstate.edu). If you have questions about your rights or welfare as a participant, please contact the Oregon State University Human Research Protection Program (HRPP) office, at (541) 737-8008 or by email at (IRB@oregonstate.edu).

Are you willing to participate in this study?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to End of Survey

**Demographic Characteristics, Work Experience and History of
Musculoskeletal Disorders**

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Choose not to answer

What is your age?

- ☐ <20
- ☐ 20-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41-45
- ☐ 46-50
- ☐ 51-55
- ☐ 56-60
- ☐ >60

What is your height?

- ☐ 4' 5"
- ☐ 4' 6"
- ☐ 4' 7"
- ☐ 4' 8"
- ☐ 4' 9"
- ☐ 4' 10"
- ☐ 4' 11"
- ☐ 5'
- ☐ 5' 1"
- ☐ 5' 2"
- ☐ 5' 3"
- ☐ 5' 4"
- ☐ 5' 5"
- ☐ 5' 6"
- ☐ 5' 7"
- ☐ 5' 8"
- ☐ 5' 9"
- ☐ 5' 10"
- ☐ 5' 11"
- ☐ 6'
- ☐ 6' 1"
- ☐ 6' 2"
- ☐ 6' 3"
- ☐ 6' 4"
- ☐ 6' 5"
- ☐ 6' 6"
- ☐ 6' 7"
- ☐ 6' 8"
- ☐ 6' 9"
- ☐ 6' 10"
- ☐ 6' 11"
- ☐ 7'

What is your weight in pounds? _____

What is your dominant hand?

- ☐ Right
- ☐ Left

What is your specialty?

- ☐ General Surgeons
- ☐ Cardiologist
- ☐ Gynecologist
- ☐ Neurosurgeon
- ☐ Orthopedic
- ☐ Pediatrician
- ☐ Plastic Surgeon
- ☐ Urologist
- ☐ Other (please specify): _____

Which of the following describes your practice setting most accurately?

- ☐ Community
- ☐ Academic
- ☐ Private
- ☐ Other (Military, Health Maintenance organization, etc.)

What is your function/position/title as a surgeon?

- ☐ Attending
- ☐ Fellow
- ☐ Resident
- ☐ Other (please specify): _____

For how many years have you been performing surgery (including residency)? _____

What is the average number of surgeries that you perform in one typical working year?

What is the average number of surgeries that you perform in one typical working week? _____

What is the average number of days do you perform surgery in one typical week? _____

What is the average number of surgeries that you perform in one typical working day?

What is the average number of hours that one typical surgery last? _____

Have you ever been diagnosed with any musculoskeletal disorders? _____

☐ Yes

☐ No

If No Is Selected, Then Skip to End of Block

Which type(s) of musculoskeletal disorders have you been diagnosed that you attribute to your work as a surgeon? (Check all that apply)

- ☐ Low back pain
- ☐ Wrist/forearm tendinitis
- ☐ Wrist/forearm tenosynovitis
- ☐ Lateral epicondylitis
- ☐ Plantar fasciitis
- ☐ CTS (Carpal tunnel syndrome)
- ☐ Shoulder pain (tendinitis)
- ☐ Knee osteoarthritis
- ☐ Tennis Elbow
- ☐ Prolapsed / herniated disc
- ☐ Rotator cuff injury
- ☐ ACL/ meniscus tear / Knee injury
- ☐ Other (please specify): _____

Have you ever received therapy or treatment because of the musculoskeletal disorder?

- ☐ Yes
- ☐ No

Have you ever been hospitalized because of the trouble?

- ☐ Yes
- ☐ No

Have you ever had to change your job routine because of the musculoskeletal disorder?

- ☐ Yes
- ☐ No

What is the percentage for each type(s) of surgery that you perform? (The total should equal 100%)

_____ Open

_____ Laparoscopic

_____ Robotic

_____ Other (please specify):

This is the last question regarding your Demographic Characteristics. After clicking "Next" button you will NOT be able to change your answers to those questions. If you want to review/modify your answers, you can use the "Back" button to go back to the page.

Open Surgery

How many years have you been performing open surgery (including residency)? ____

What is the average number of open surgeries that you perform in one typical working year?

—

What is the average number of open surgeries that you perform in one typical working week? ____

What is the average number of days that you perform open surgery in one typical week?

—

What is the average number of open surgeries that you perform in one typical working day?

—

What is the average number of hours that one typical open surgery last? ____

How much time do you spend standing during one typical open surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Do you have access to adjustable operating room table while performing open surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please describe the operating room table setting while performing open surgery.

How often do you adjust the operating room table while performing open surgery?

- ☐ Never
- ☐ Once before each open surgery
- ☐ Multiple times during one open surgery

How often do you adjust the operating room table while performing open surgery to relieve discomfort?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Please describe the operating room table setting while performing open surgery.

- ☐ The operating room table is located at height level below my upper thigh
- ☐ The operating room table is located at height level between my upper thigh and hip
- ☐ The operating table is located at height level between my hip and elbow
- ☐ The operating table is located at height level above my elbow

Do you use sitting stool while performing open surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to How much time do you spend using monitor(s) during one typical open surgery?

Do you have access to adjustable sitting stool while performing open surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to How much time do you spend using monitor(s) during one typical open surgery?

How often do you adjust sitting stool while performing open surgery?

- ☐ Never
- ☐ Once before each open surgery
- ☐ Multiple times during one open surgery

How often do you adjust the sitting stool to relieve discomfort while performing open surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

How much time do you spend using monitor(s) during one typical open surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

If Never Is Selected, Then Skip to How often do you use arm support while performing open surgery?

For what purpose(s) do you use monitor in operating room while performing open surgery?

(check all that apply)

- ☐ For observing medical records (surgical images, x-ray images, ...)
- ☐ For observing patient vital signs
- ☐ For observing camera view
- ☐ Other (please specify) _____

Do you have access to adjustable monitor while performing open surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please describe monitor setting while performing open surgery?

How often do you adjust monitor while performing open surgery?

- ☐ Never
- ☐ Once before each open surgery
- ☐ Multiple times during one open surgery

How often do you adjust the monitor to relieve discomfort while performing open surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Please describe monitor setting while performing open surgery? (check all that apply)

- ☐ The monitor is located directly in front of me
- ☐ The monitor is located slightly to the side
- ☐ The monitor is located off to the side
- ☐ The monitor is located below hand height
- ☐ The monitor is located between hand and eye height
- ☐ The monitor is located above the eye height
- ☐ The monitor is located far and closed enough to avoid twist in neck/body

How often do you use arm support while performing open surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

How often do you use foot pedal while performing open surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

If Never Is Selected, Then Skip to Please indicate the extent to which you agree with each of the following statements regarding your posture during performing open surgery:

Are you required to look down before operating the foot pedal while performing open surgery?

- ☐ Yes
- ☐ No

Are you required to keep the static posture during open surgery to prevent loss of contact with the foot pedal?

- ☐ Yes
- ☐ No

Please indicate the extent to which you agree with each of the following statements regarding your posture during performing open surgery:

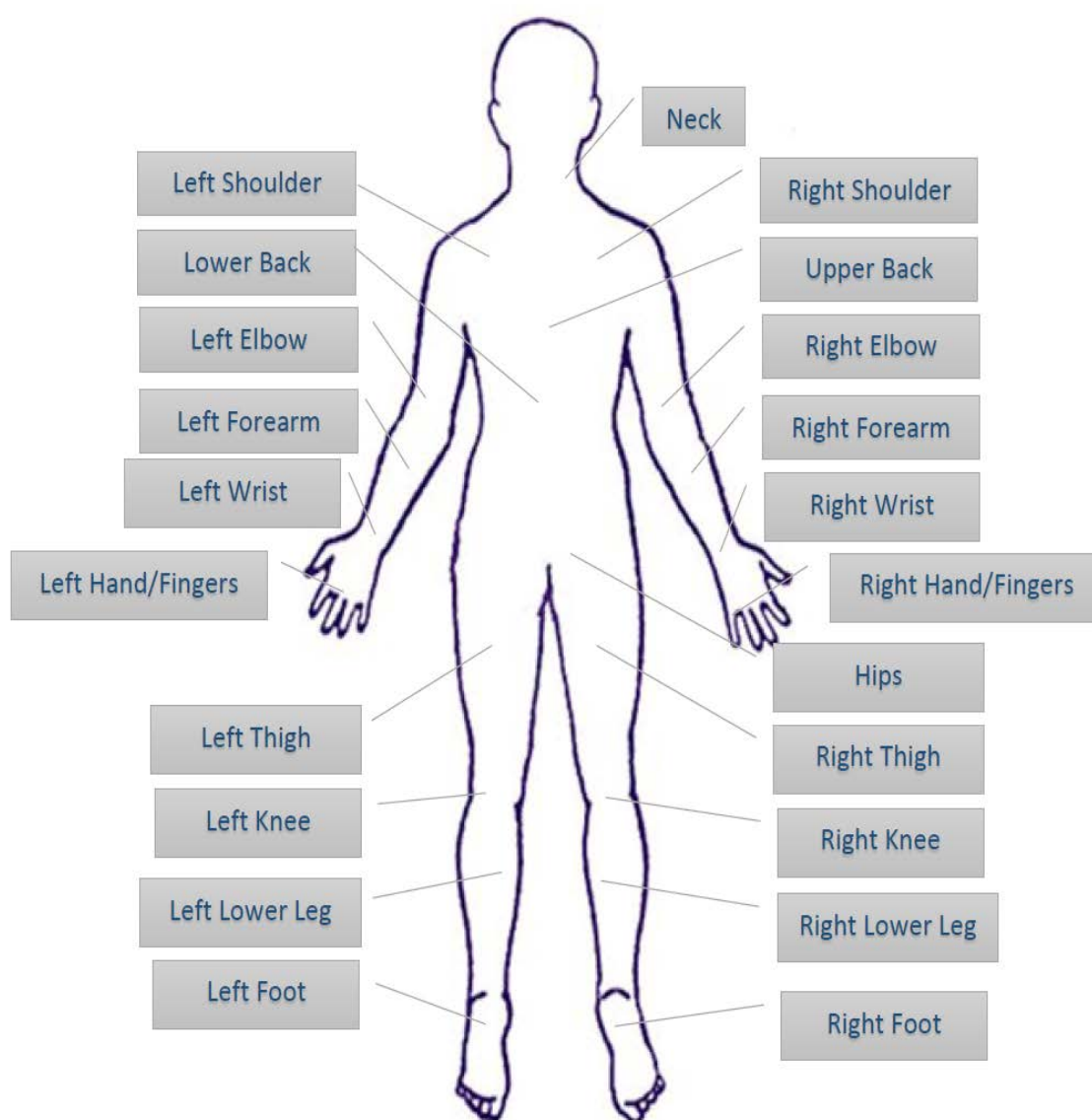
	Never	Occasion ¹¹	Often	Always
I experience difficulty positioning myself around the operating room table.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I need to keep a static posture during surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my neck is bent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my neck is twisted towards the left or right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my shoulders are lifted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my trunk is twisted towards the left or right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my trunk is in asymmetrical position.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my elbow is extended or flexed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my wrist is bent or twisted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my fingers are flexed or extended.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery the weight of my entire body is supported by my legs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my knees are bent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Do you experience discomfort after performing open surgery? Please tick boxes corresponding

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please indicate the extent to which you agree with each of the following statements regarding your posture during performing open surgery:

The following diagram shows the approximate position of body parts. Please tick boxes corresponding the location(s) of the discomfort after performing open surgery. (Discomfort may include pain, stiffness, numbness or burning sensation)



Please answer questions regarding the frequency and severity of discomfort after performing open surgery (Discomfort may include pain, stiffness, numbness or burning sensation)

How often do you experience discomfort in the selected body part?

- ☐ Occasionally
- ☐ Often
- ☐ Always

Please indicate the extent to which you agree with each of the following statements regarding your job as open surgeon:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I find surgical procedures hurried or rushed while performing open surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find open surgical tasks difficult and complex.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find my operating environment distracting while performing open surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have too many job tasks to do while performing open surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel pressured when I am performing open surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I take time to pause or stretch during a typical open surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can ask and enquire during open surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I made a mistake during open surgery I find support from my colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My work tasks while performing open surgery depend on other colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experience communication breakdowns during open surgery that lead to delays in surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This is the last question regarding your experience in Open Surgery. After clicking "Next" button you will NOT be able to change your answers to those questions. If you want to review/modify your answers, you can use the "Back" button to go back to the page.

Laparoscopic Surgery

How many years have you been performing laparoscopic surgery (including residency)?

—

What is the average number of days that you perform laparoscopic surgery in one typical week? __

What is the average number of laparoscopic surgeries that you perform in one typical working week? __

What is the average number of days do you perform laparoscopic surgery in one typical week? __

What is the average number of laparoscopic surgeries that you perform in one typical working day? __

What is the average number of hours that one typical laparoscopic surgery last? __

How often do you spend time standing during one typical laparoscopic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Do you have access to adjustable operating room table while performing laparoscopic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please describe the operating room table setting while performing laparoscopic surgery.

How often do you adjust the operating room table while performing laparoscopic surgery?

- ☐ Never
- ☐ Once before each laparoscopic surgery
- ☐ Multiple times during one laparoscopic surgery

How often do you adjust the operating room table to relieve discomfort while performing laparoscopic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Please describe the operating room table setting while performing laparoscopic surgery?

- ☐ The operating room table is located at height level below my upper thighs
- ☐ The operating room table is located at height level between my upper thigh and hip
- ☐ The operating table is located at height level between my hip and elbow
- ☐ The operating table is located at height level above my elbow

Do you use a sitting stool while performing laparoscopic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to How much time do you spend using monitor(s) during one typical laparoscopic surgery?

Do you have access to an adjustable sitting stool while performing laparoscopic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to How much time do you spend using monitor(s) during one typical laparoscopic surgery?

How often do you adjust the sitting stool while performing laparoscopic surgery?

- ☐ Never
- ☐ Once before each laparoscopic surgery
- ☐ Multiple times during one laparoscopic surgery

How often do you adjust the sitting stool while performing laparoscopic surgery to relieve discomfort?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

How much time do you spend using monitor(s) during one typical laparoscopic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

If Never Is Selected, Then Skip to How often do you use arm support while performing laparoscopic surgery?

For what purpose(s) do you use a monitor in the operating room while performing laparoscopic surgery? (check all that apply)

- ☐ For observing medical records (surgical images, x-ray images, ...)
- ☐ For observing patient vital signs
- ☐ For observing camera view
- ☐ Other (please specify) _____

Do you have access to an adjustable monitor while performing laparoscopic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please describe monitor setting while performing laparoscopic surgery?

How often do you adjust the monitor while performing laparoscopic surgery?

- ☐ Never
- ☐ Once before each laparoscopic surgery
- ☐ Multiple times during one laparoscopic surgery

How often do you adjust the monitor to relieve discomfort while performing laparoscopic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Please describe the monitor setting while performing laparoscopic surgery? (check all that apply)

- ☐ The monitor is located directly in front of me
- ☐ The monitor is located slightly to the side
- ☐ The monitor is located off to the side
- ☐ The monitor is located below hand height
- ☐ The monitor is located between hand and eye height
- ☐ The monitor is located above the eye height
- ☐ The monitor is located far and closed enough to avoid twist in neck/body

How often do you use an arm support while performing laparoscopic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

How often do you use a foot pedal while performing laparoscopic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

If Never Is Selected, Then Skip to Please indicate the extent to which you agree with each of the following statements regarding your posture during performing laparoscopic surgery:

Do you need to look down before operating the foot pedal while performing laparoscopic surgery?

- ☐ Yes
- ☐ No

Do you need to keep a static posture during surgery to prevent loss of contact with the foot pedal while performing laparoscopic surgery?

- ☐ Yes
- ☐ No

Please indicate the extent to which you agree with each of the following statements regarding your posture during performing laparoscopic surgery:

	Never	Occasionally	Often	Always
I experience difficulty positioning myself around the operating room table.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I need to keep a static posture during surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my neck is bent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my neck is twisted towards the left or right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my shoulders are lifted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my trunk is twisted towards the left or right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my trunk is in asymmetrical position.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my elbow is extended or flexed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my wrist is bent or twisted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my fingers are flexed or extended.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery the weight of my entire body is supported by my legs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my knees are bent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

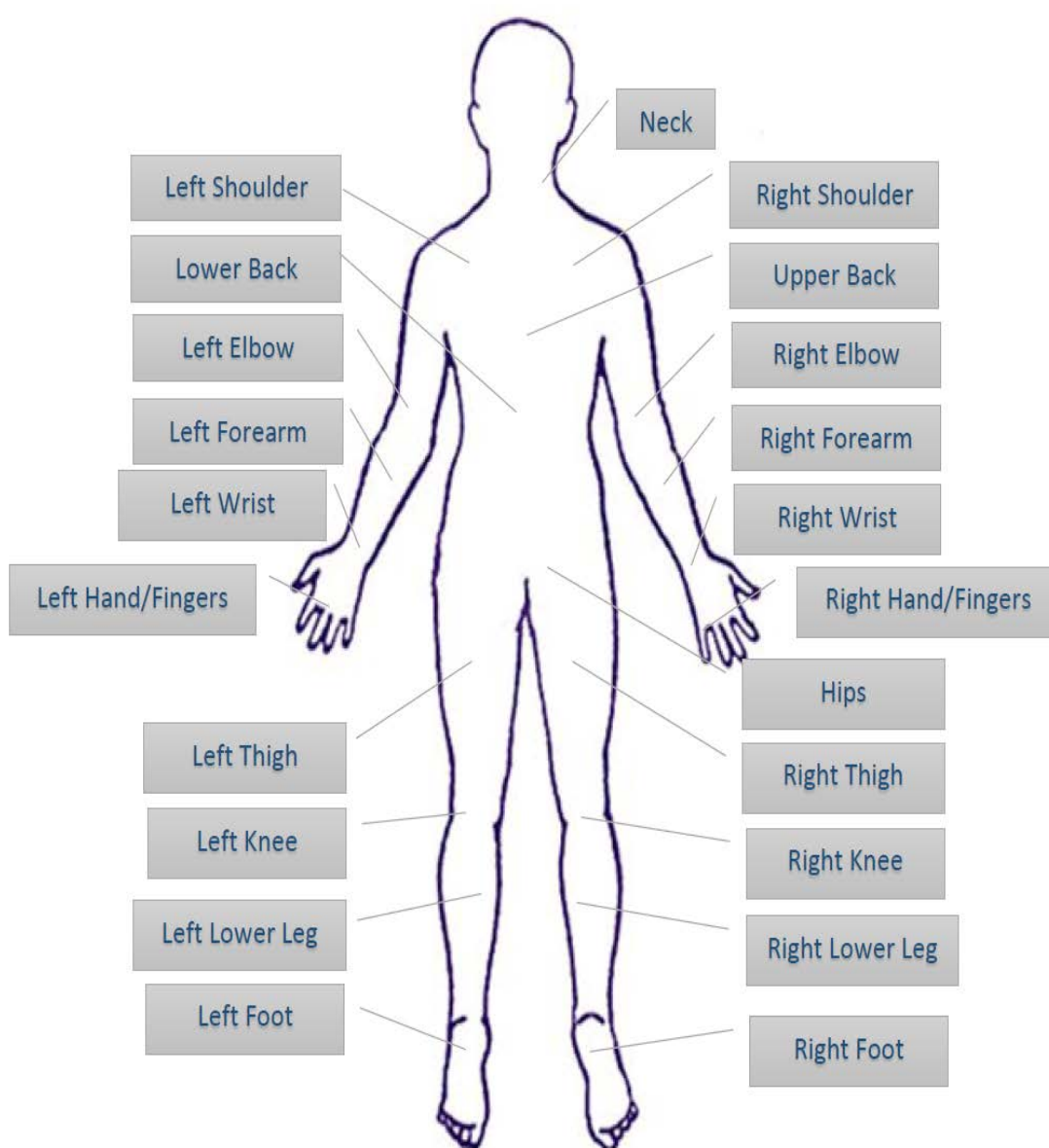
Do you experience discomfort after performing laparoscopic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please indicate the extent to which you agree with each of the following statements regarding your posture during performing laparoscopic surgery:

The following diagram shows the approximate position of body parts. Please tick boxes corresponding the location(s) of the discomfort after performing laparoscopic surgery.

(Discomfort may include pain, stiffness, numbness or burning sensation)



Please answer questions regarding the frequency and severity of discomfort after performing laparoscopic surgery (Discomfort may include pain, stiffness, numbness or burning sensation):

How often do you experience discomfort in the selected body part?

- ☐ Occasionally
- ☐ Often
- ☐ Always

Please indicate the extent to which you agree with each of the following statements regarding your job as laparoscopic surgeon:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I find surgical procedures hurried or rushed while performing laparoscopic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find laparoscopic surgical tasks difficult and complex.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find my operating environment distracting while performing laparoscopic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have too many job tasks to do while performing laparoscopic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel pressured when I am performing laparoscopic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I take time to pause or stretch during a typical laparoscopic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can ask and enquire during laparoscopic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I made a mistake during laparoscopic surgery, I find support from my colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My work tasks while performing laparoscopic surgery depend on other colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experience communication breakdowns during laparoscopic surgery that lead to delays in surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This is the last question regarding your experience in Laparoscopic Surgery. After clicking "Next" button you will NOT be able to change your answers to those questions. If you want to review/modify your answers, you can use the "Back" button to go back to the page.

Robotic Surgery

How many years have you been performing robotic surgery (including residency)? __

What is the average number of robotic surgeries that you perform in one typical working year? _

What is the average number of robotic surgeries that you perform in one typical working week? __

What is the average number of days do you perform robotic surgery in one typical week?
__

What is the average number of robotic surgeries that you perform in one typical working day? _

What is the average number of hours that one typical robotic surgery last? __

How often do you spend time standing during one typical robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Do you have access to a console with an adjustable work surface while performing robotic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please describe the operating room table setting while performing robotic surgery.

How often do you adjust the console's work surface setting while performing robotic surgery?

- ☐ Never
- ☐ Once before each robotic surgery
- ☐ Multiple times during one robotic surgery

How often do you adjust the console's work surface setting to relieve discomfort while performing robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Please describe the console setting while performing robotic surgery.

- ☐ The work surface is located at height level below my upper thigh
- ☐ The work surface is located at height level between my upper thigh and hip
- ☐ The work surface is located at height level between my hip and elbow
- ☐ The work surface is located at height level above my elbow

Do you use a sitting stool while performing robotic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to How much time do you spend using monitor(s) during one typical robotic surgery?

Do you have access to an adjustable sitting stool while performing robotic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to How much time do you spend using monitor(s) during one typical robotic surgery?

How often do you adjust the sitting stool while performing robotic surgery?

- ☐ Never
- ☐ Once before each robotic surgery
- ☐ Multiple times during one robotic surgery

How often do you adjust the sitting stool to relieve discomfort while performing robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

How often do you spend time using monitor(s) during one typical robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

If Never Is Selected, Then Skip to How often do you use arm support while performing robotic surgery?

For what purpose(s) do you use a monitor in the operating room while performing robotic surgery? (check all that apply)

- ☐ For observing medical records (surgical images, x-ray images, ...)
- ☐ For observing patient vital signs
- ☐ For observing camera view
- ☐ Other (please specify) _____

Do you have access to an adjustable monitor while performing robotic surgery?

- ☐ Yes
- ☐ No

If No Is Selected, Then Skip to Please describe monitor setting while performing robotic surgery?

How often do you adjust the monitor while performing robotic surgery?

- ☐ Never
- ☐ Once before each robotic surgery
- ☐ Multiple times during one robotic surgery

If Never Is Selected, Then Skip to Please describe monitor setting while performing robotic surgery?

How often do you adjust the monitor to relieve discomfort while performing robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

Please describe the monitor setting while performing robotic surgery? (check all that apply)

- ☐ The monitor is located directly in front of me
- ☐ The monitor is located slightly to the side
- ☐ The monitor is located off to the side
- ☐ The monitor is located below hand height
- ☐ The monitor is located between hand and eye height
- ☐ The monitor is located above the eye height
- ☐ The monitor is located far and closed enough to avoid twist in neck/body

How often do you use an arm support while performing robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

How often do you use a foot pedal while performing robotic surgery?

- ☐ Never
- ☐ Occasionally
- ☐ Often
- ☐ Always

If Never Is Selected, Then Skip to Please indicate the extent to which you agree with each of the following statements regarding your posture during performing robotic surgery:

Do you need to look down before operating the foot pedal while performing robotic surgery?

- ☐ Yes
- ☐ No

Do you need to keep a static posture during surgery to prevent loss of contact with the foot pedal while performing robotic surgery?

- ☐ Yes
- ☐ No

Please indicate the extent to which you agree with each of the following statements regarding your posture during performing robotic surgery:

	Never	Occasionally	Often	Always
I experience difficulty positioning myself around the operating room table.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I need to keep a static posture during surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my neck is bent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my neck is twisted towards the left or right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my shoulders are lifted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my trunk is twisted towards the left or right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my trunk is in asymmetrical position.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my elbow is extended or flexed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my wrist is bent or twisted.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my fingers are flexed or extended.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery the weight of my entire body is supported by my legs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I perform surgery my knees are bent.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

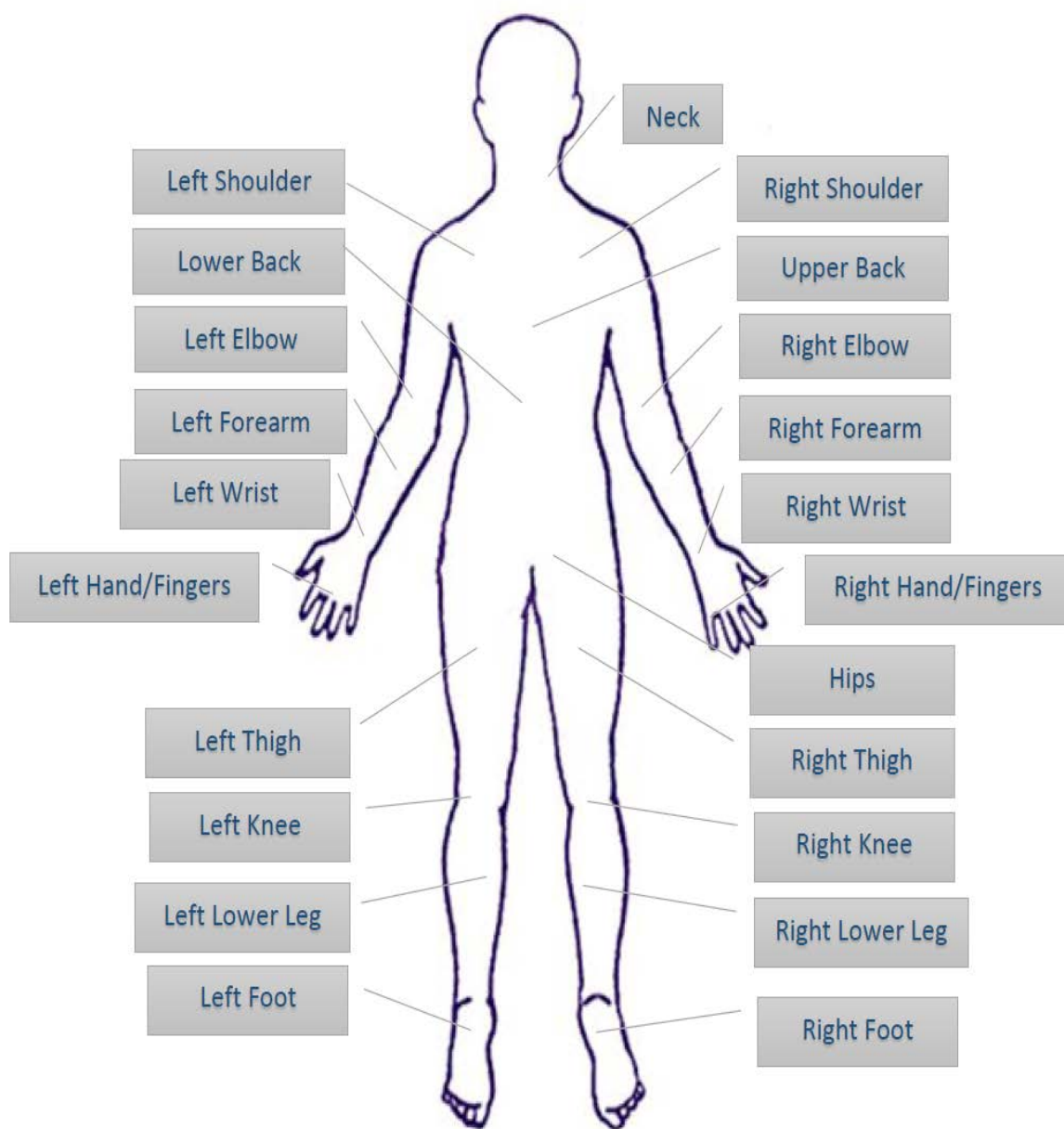
Do you experience discomfort after performing robotic surgery?

☐ Yes

☐ No

If No Is Selected, Then Skip to Please indicate the extent to which you agree with each of the following statements regarding your posture during performing open surgery:

The following diagram shows the approximate position of body parts. Please tick boxes corresponding the location of discomfort after performing robotic surgery (Discomfort may include pain, stiffness, numbness or burning sensation)



Please answer questions regarding the frequency and severity of discomfort after performing robotic surgery (Discomfort may include pain, stiffness, numbness or burning sensation)

How often do you experience discomfort in the selected body part?

- ☐ Occasionally
- ☐ Often
- ☐ Always

Please indicate the extent to which you agree with each of the following statements regarding your job as robotic surgeon:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I find surgical procedures hurried or rushed while performing robotic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find robotic surgical tasks difficult and complex.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find my operating environment distracting while performing robotic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have too many job tasks to do while performing robotic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel pressured when I am performing robotic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I take time to pause or stretch during one typical robotic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can ask and enquire during robotic surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I made a mistake during robotic surgery I find support from my colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My work tasks while performing robotic surgery depend on other colleagues.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experience communication breakdowns during robotic surgery that lead to delays in surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This is the last question regarding your experience in Robotic Surgery. After clicking "Next" button you will NOT be able to change your answers to those questions. If you want to review/modify your answers, you can use the "Back" button to go back to the page.

Psychosocial Factors

Are you aware of any ergonomics guidelines which can be applied to reduce your physical fatigue while performing surgeries (e.g. placing operating room table at elbow height for open surgery or placing laparoscopic camera view monitor at height between your head and hands preventing over bending your neck and trunk)

- ☐ Yes
- ☐ No

Do you apply them while performing surgery?

- ☐ Yes
- ☐ No

From your opinion, what are the reason(s) for not applying ergonomics guidelines? (Check all that apply)

- ☐ They are not applicable (e.g., My institution does not provide adjustable tables and chairs for applying them)
- ☐ I cannot apply them because the ergonomics settings that satisfies my needs conflicts with others'.(e.g. the ideal table height for me is too high fo other surgeons)
- ☐ I do not find them helpful.
- ☐ Other (please specify) _____

Do you know how to report a workplace injury?

- ☐ Yes
- ☐ No

What level of safeguards are in place to prevent work-related injury to surgeons (e.g. personal protective equipment)?

- ☐ Exceptional
- ☐ Adequate safeguards
- ☐ Inadequate safeguards
- ☐ No opinion

What level of support is offered to surgeons' post-injury (e.g. rehabilitation)?

- ☐ Exceptional
- ☐ Adequate safeguards
- ☐ Inadequate safeguards
- ☐ No opinion

How accessible are support resources at your institution for injured surgeons?

- ☐ Exceptional
- ☐ Adequate safeguards
- ☐ Inadequate safeguards
- ☐ No opinion

Please indicate the extent to which you agree with each of the following statements regarding your job:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I am anxious while performing surgery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My work atmosphere is comfortable.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This is the last question regarding Psychosocial Factors. If you want to review/modify your answers regarding Psychosocial Factors, you can use

the "Back" button to go back to the page. After clicking "Submit" button you will NOT be able to change your answers to those questions.

Please click "Submit" to submit your answers.

Your survey has been successfully submitted. If you are interested in winning \$100 Amazon gift card via a lottery, please click "Yes"; if not, please click "No" to exit the survey.

- ☐ Yes
- ☐ No

Lottery

Please enter your contact information:

1. Name: _____
2. Email: _____
3. Phone number: _____

Thank you for your participation.

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