AN ABSTRACT OF THE THESIS OF

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Title: The Effect of Zumbini® on Physical Activity of Young Children with and without Disabilities

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Samuel W. Logan

Physical activity is important for young children with and without disabilities. However, recent investigations have found that young children with and without disabilities spend less time in physical activity than is recommended. Family and music factors have been shown to positively affect physical activity of this population in previous studies. An inclusive program is one potential way to improve physical activity of young children with and without disabilities. Zumbini® is a family-based physical activity program designed for children 0 to 4 years old and their caregivers. The purpose of this study is to determine the effects of Zumbini® on physical activity amount of young children with and without disabilities.

The current study applied a single subject A-B research design in an inclusive playgroup to investigate the effect of Zumbini® on physical activity amounts of young children with and without disabilities. By comparing movement counts from triaxial accelerometers recording during a 4-week baseline phase (free play session) and a 4-week intervention phase (Zumbini® session), we found that physical activity amounts changes trends of the participants in individual level. In addition, nonoverlap of all pairs (NAP) was applied to indicate the effect of
Zumbini®. Eight participants (5 without disabilities: mean age=33.2±8.319 months, 2 males; 3 with disabilities: mean age=30.33±13.65 months, 2 males) with complete data collection were used for data analysis. The change of the physical activity amounts and the trend within each individual were varied. The physical activity amounts on wrists ranged from 1467.84 counts/min to 14927.05 counts/min. The physical activity amounts on hips ranged from 96.17 counts/min to 4952.10 counts/min. Using NAP analysis, the majority of the participants experienced medium to large intervention effects in physical activity amount changes. The reason for the varied physical activity amount change and the trend in each participant were discussed in this study. Future research could include larger sample sizes, increased intervention time, and different measuring methods to fully capture the effect of Zumbini®.
The Effect of Zumbini® on Physical Activity of Young Children with and without Disabilities

by
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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.

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Chun-Wei Chang, Author
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The Effect of Zumbini® on Physical Activity of Young Children with and without Disabilities

Chapter 1. Introduction

Physical activity is important for young children. For the purpose of this paper, young children are defined as children 5 years old and younger. According to the World Health Organization (WHO), physical activity is defined as bodily movement that is produced by skeletal muscle and results in energy expenditure and includes a variety of activities undertaken in daily lives, such as playing and working (World Health Organization, n.d.). Physical activity is associated with important health outcomes for young children, such as gross motor development (Williams et al., 2008), metabolic health (Timmons et al., 2012), psychosocial health (Lee & Carson, 2018), bone and skeletal health (Pitukcheewanont, Punyasavatsut, & Feuille, 2010), and cognition (Carson et al., 2016). Physical activity can benefit young children with disabilities as well. Children with disabilities have been shown to have improved movement and body function after physical activity interventions (Looper & Ulrich, 2010). Physical activity for young children with disabilities also facilitates achievement of their clinical rehabilitation goals (Casey, Pickard, Ulrich, & MacNeil, 2018; Halperin et al., 2013). Therefore, physical activity plays a crucial role in improving young children’s development and physical health.

Despite known benefits, young children with and without disabilities tend to engage in insufficient physical activity to reap health benefits (Beets, Bornstein, Dowda, & Pate, 2011; Pate et al., 2015). It is recommended that young children are physically active at least 120 to 180 minutes every day, and spend 90 to 120 minutes in moderate to vigorous physical activity (MVPA) every day (American Academy of Pediatrics, American Public Health Association, & National Resource Center for Health and Safety in Child Care and Early Education, 2011; National Health Service, n.d.). However, most young children do not meet this guideline (Beets et al., 2011; Pate et al., 2015). Young children spend only 2% to 41% of their day in MVPA,
which is less than sedentary activity (34% to 94%) and light-intensity physical activity (4% to 33%) (Hnatiuk, Salmon, Hinkley, Okely, & Trost, 2014). A previous study indicated that approximately 37% of children with disabilities have never participated in organized physical activity in their communities (Bedell et al., 2013). We can infer that young children with and without disabilities participate less in physical activity than in sedentary activity.

Young children with disabilities tend to be less active than those without disabilities (National Center on Health, Physical Activity and Disability, n.d.). In children and adolescents (4 to 20 years old), youth with disabilities engaged in lower levels of MVPA than youth without disabilities (Jung, Leung, Schram, & Yun, 2018). Moreover, the physical activity difference between youth with and without disabilities were affected by age, with younger youth with disabilities participating in less physical activity than those without disabilities. Personal, social, environmental, policy, and program-related barriers and facilitators are factors that influence physical activity amount among young children with disabilities (Shields, Synnot, & Barr, 2011). Young children with chronic diseases and disabilities seldom engage in fitness and activity programs due to their health problems (Newacheck et al., 1998). Young children with disabilities perform in less physical activity compared to children without disabilities (Benjamin, Lucas-Thompson, Little, Davies, & Khetani, 2017). Therefore, it is necessary to provide inclusive physical activity programs to increase the physical activity levels of young children with disabilities.

The physical activity that young children participate in can be different according to the environment (Brown, Odom, Li, & Zercher, 1999; Frank, Flynn, Farnell, & Barkley, 2018; McIver, Brown, Pfeiffer, Dowda, & Pate, 2009). Play is a common physical activity that young children participate in. Young children’s play activities can be classified into two forms: free play (unstructured play) and structured play (Playgroup centre, n.d.). Previous studies indicated that young children perform more MVPA during free play (7.7 min/hr) than during structured...
play (6.5 min/hr) (Frank et al., 2018; Pate et al., 2014). However, those who were active in free play (1970 ± 647 counts/min) decreased their activity during structured play (1462 ± 535 counts/min). Children who were the least (530 ± 239 counts/min) to moderately active (1031 ± 112 counts/min) in free play increased activity during structured play (least active: 1313 ± 413 counts/min, moderately active: 1383 ± 345 counts/min)(Frank et al., 2018). Format of the activity, intrinsic motivation, and preference could affect young children’s physical activity participation. Family and music are two factors that have been indicated to influence the physical activity amounts of young children:

**Family Factor**

Family is one of the factors that can increase the amount of physical activity for young children with and without disabilities (Xu, Wen, & Rissel, 2015). Parents’ overweight status is related to low levels of physical activity among young children (Klesges, Eck, Hanson, Haddock, & Klesges, 1990; Moore et al., 1991). Furthermore, parents’ health behavior, including sedentary time and physical activity rate, affects young children’s participation in physical activity (Oliver, Schofield, & Schluter, 2010; Xu et al., 2015). Parents’ encouragement and support can increase young children’s physical activity (Xu et al., 2015). Previous studies have shown the positive effect of family-based interventions on improving the health of young children with obesity (Davison, Jurkowski, Li, Kranz, & Lawson, 2013; O’Dwyer, Fairclough, Knowles, & Stratton, 2012). Family-based physical activity programs could improve the health behavior and decrease obesity risks among young children. In addition, parental behaviors have been shown to influence the physical activity behavior of children with disabilities. Parents’ beliefs, perceived competence, and support on the children with disabilities are crucial factors in promoting physical activity behavior of the children (Pitchford, Siebert, Hamm, & Yun, 2016; Siebert, Hamm, & Yun, 2017). Therefore, parental involvement in physical activity interventions could be an important factor for increasing physical activity among
Music Factor

Music could be another factor to increase physical activity among young children. In general, the psychological response produced by music can alter mood and encourage social interaction (Murrock & Higgins, 2009). From a physiological perspective, music can cue movement and physical activity (Murrock & Higgins, 2009). However, little is known about the specific mechanism by which music increases physical activity of young children with and without disabilities. Dance includes music and physical activity, and requires a person to listen to music and make movements according to the culture and the meaning of the music (Boyd, 2004). In turn, dance, as a form of physical activity, has been shown to reduce obesity rates among children from 6 to 17 years old (Mo-suwan, Pongprapai, Junjana, & Puetpaiboon, 1998). In addition, rhythm and dance improved gait length of children with cerebral palsy in 6 to 20 years old (Kwak, 2007) and thus may have additive benefits for children with disabilities. Therefore, combining music and rhythm to encourage physical activity has the potential to motivate young children with and without disabilities in increasing physical activity.

Zumbini® is a program created by Zumba® fitness and BabyFirst TV. It provides 45 minutes of family-based, structured physical activity classes that incorporates music to encourage physical activity. It is designed for 0 to 4 years old children and their caregivers. The classes are offered once a week and in quarterly sessions, which ranges between 6-16 weeks per session. In Zumbini® classes, the instructor provides 11 to 14 songs and instructs dance, singing, and instrument play alternatively according to the lesson plan that is suggested by the Zumbini® instructor training manual (Zumba Fitness, 2016). The music is based on the Zumbini® songbook bundle, which includes a songbook, a password to the Zumbini® app, and a CD with 20 songs, that is designed by the Zumbini® company. The music instruments used in Zumbini® classes include wrist bells, Bongo drums, rhythm sticks, and egg shakers. In
addition, scarfs are used in the classes to encourage dance and to play peek-a-boo. Before a session starts, the families who sign up for the session can get one of the Zumbini® songbook bundles that would be focused on the session and play the music at home. The family factor in Zumbini® classes is that the caregivers dance and interact with their children. The music factor in Zumbini® classes is that the caregivers and the children are provided with music and are encouraged to engage in physical activity and sing together. Based on the design of Zumbini®, it has the potential to be applied in inclusive settings and increase physical activity of young children with and without disabilities. Zumbini® is relatively new, and research is limited. It remains unknown the effects of Zumbini® on young children’s physical activity amounts.

**Problem Statement**

The purpose of this study is to determine the effect of a Zumbini® session on physical activity amount of young children with and without disabilities. The objective is to investigate if young children’s physical activity amounts during the 3 to 4 classes of the Zumbini® session differs from that during a general free play situation in an inclusive playgroup. The hypothesis is that the young children will be more physically active during Zumbini® session than during a comparable period of a free play session.
Chapter 2. Methods

Study Design

An A-B single subject research design was applied in this study. A Single subject design has been suggested to investigate the effect of interventions in real-life situations (Portney & Watkins, 2009). Examining individual-level differences in a target behavior, such as physical activity, between baseline and intervention can establish evidence-based practice for clinical decision-making (Portney & Watkins, 2009). To increase the internal validity of single subject study designs, individual data is analyzed for more than one participant (Byiers, Reichle, & Symons, 2012; Horner et al., 2005; Kratochwill et al., 2010; Portney & Watkins, 2009). Therefore, in this study, we gathered, analyzed and interpreted the difference in physical activity amounts of inclusive playgroup participants between the free play session and the Zumbini® session, using each participant as a unit of analysis. Four data points were collected for baseline, which is the suggested minimum amount of data points for a single subject research design (Byiers et al., 2012; Portney & Watkins, 2009), and was used to establish a stable pattern of behavior prior to introducing the Zumbini® intervention. We provided 4 weeks of the free play session in the baseline phase (A phase) followed by 4 weeks of the Zumbini® session in the intervention phase (B phase).

Participants

The maximum suggested class size for a Zumbini® session is 12 to 14 children. Therefore, the goal of the current study was to recruit 14 children and their caregivers. The target population was focused on local residents who live in Corvallis, Oregon. Children were eligible if they (a) were between 1 to 4 years of age at the entry into the study, either with or without disabilities according to the caregiver’s report, (b) had independent head control, (c) could attend free play and Zumbini® sessions weekly. The exclusion criteria were: (a) outside age range, (b) no head control, (c) child displayed aggressive or violent behavior toward self or
others, or (d) attendance rate of the families dropped below 60% in either the free play or the Zumbini® session. Recruitment occurred through social media and local contacts of the principal investigator and research teams. All study procedures were approved by the institutional review board at Oregon State University. Written informed parental/guardian consent was obtained prior to data collection. Young children assents were obtained prior to participation in each session (e.g., “do you want to play?” and “do you want to sing and dance?”).

**Baseline Phase: Free Play Session**

Each free play session was 45 minutes, once a week for 4 weeks, in an indoor gymnasium (Ross, et al., 2017). During each session, the young children and caregivers were encouraged to engage in unstructured free play behavior, while the study team members were bystanders on the perimeter of the play-space. Developmentally appropriate play equipment was provided, such as balls, cones, mats, mesh tunnels, slides, and music instruments, among other toys. The size of the play space was 2300 square feet. To prevent harm and injury of the participants, two-by-two square foot foam floor mats was laid out in a 52’ by 44’ pattern on the play space.

**Intervention Phase: Zumbini® Session**

Zumbini® is a movement program that focuses on dancing, singing, playing, and interaction for both children and the caregivers (Zumba Fitness, 2016). Each Zumbini® class was 45 minutes, once a week for 4 weeks, in an indoor gymnasium. In every Zumbini® class, 13 songs were played for the young children and their caregivers. The instructor led the dancing, singing, and instrument use to encourage physical activity. The class format included an opening dance, singing a welcome song, structured dance, dancing with scarves, singing peek-a-boo, using instruments, unstructured dance, singing a quiet song, and singing a good-bye song. These activities and songs were based on one of the Zumbini® songbook “Kalino
finds the music” (Zumba fitness, 2013). The Zumbini® instructor in the current study has taken a 2-day instructor training hosted by Zumbini® and has one year of teaching experience. In Zumbini® classes, wrist bells, Bongo drums, rhythm sticks, and egg shakers were used to change the tempo of the music and increase the rhythm movement of the participants. To facilitate the interaction between the children and the caregivers, scarves were provided for one of the dances and to play peek-a-boo. In addition, an audio system was used in Zumbini® classes for broadcasting music and to ensure that all the participants and caregivers heard the instruction. Although caregivers were involved in both the free play session and the Zumbini® session, the instructions provided in the Zumbini® session were the facilitators for caregivers’ engagement in interaction with the participants.

To prevent other factors affecting the influence of family and music factors in Zumbini® classes, there were some similarities between the free play session and Zumbini® session. First, the setting was the same in the free play session and Zumbini® classes to prevent the participants from changing their physical activity amount due to a different environment. We provided foam mats in a gymnasium to make a 2300 square feet space for the participants to engage in both the free play session and Zumbini® session. Second, music instruments were provided in both the free play session and the Zumbini® session to increase the participants’ familiarity to the play equipment. In Zumbini® classes, wrist bells, drums, rhythm sticks, and egg shakers were used to increase the participants’ engagement to the music. Therefore, providing these instruments in free play session could give the participants opportunities to learn how to play the instruments and ensure consistency across phases. Finally, the caregivers were involved in both the free play situation and Zumbini® classes to increase the similarity of the caregivers’ involvement across the two phases. Caregivers in both phases could encourage the participants’ physical activity amounts according to different environment characteristics. Table. 1 compares the similarities and difference between the
free play session and Zumbini® session.

Table. 1. The similarities and difference between free play session and Zumbini® session in this study

<table>
<thead>
<tr>
<th>Similarities/ difference</th>
<th>Free play session</th>
<th>Zumbini® session</th>
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<tbody>
<tr>
<td><strong>Space and size</strong></td>
<td>A 2300 square feet space in an indoor gymnasium</td>
<td>A 2300 square feet space in an indoor gymnasium</td>
</tr>
<tr>
<td><strong>Length, frequency, and time</strong></td>
<td>4 weeks, once a week, 45 minutes</td>
<td>4 weeks, once a week, 45 minutes</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>Music instruments and developmentally appropriate play equipment</td>
<td>Music instruments and scarves</td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>Free play behavior without instruction</td>
<td>Singing, dancing, playing, and instrument use with instructions</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td>Participants and their caregivers</td>
<td>Participants and their caregivers</td>
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</table>

**Measures**

Physical activity amount was measured using GT3X+ accelerometers (ActiGraph, 2013) (Chen & Bassett, 2005; Pate, O’Neill, & Mitchell, 2010). The GT3X+ is a triaxial accelerometer that measures acceleration along the vertical, anterior-posterior, and mediolateral axis. The device can detect accelerations ranging between -6 to 6 g with a frequency ranging from 0.25 Hz to 2.5 Hz. The outputs include vertical, anterior-posterior, and mediolateral axis activity counts, which can represent the physical activity amount of the young children. A 5 second epoch was used in this data collection process given the frequent and intermittent movement
patterns that characterize this population age (Cliff, Reilly, & Okely, 2009). Trained research assistants attached and removed the accelerometers from the participants before and after every free play and Zumbini® class. To fully record the physical activity amounts of the participants, each participant wore 2 accelerometers for 45 minutes during the free play situation and Zumbini® classes. The accelerometers were secured by a scarf on each participant’s non-dominant wrists, and by an elastic band on the right hip (Johansson, Ekelund, Nero, Marcus, & Hagströmer, 2015; Elin Johansson, Larisch, Marcus, & Hagströmer, 2016). After every data collection, all the accelerometer data were downloaded from the accelerometers and were recorded on a computer by the lead researcher. In addition, the lead researcher took field notes following each data collection session about the caregivers’ and participants’ type of physical activity behavior and caregiver-participant interaction. The caregivers also reported their at-home usage of the Zumbini® bundle.

**Data Analysis**

The purpose of this study is to determine if young children could perform more physical activity in the Zumbini® session than in the free play session. In turn, the effect of Zumbini® on physical activity was examined by comparing physical activity amounts between baseline and intervention phases at the individual level. Visual analysis for the trend of physical activity amounts change between different phases and Nonoverlap of all pairs (NAP) were applied to analyze the effect of Zumbini®. The steps of calculation and analysis are as follow:

**Step 1: Total movement counts**

Total movement counts were derived from triaxial accelerometer recordings. The movement counts and the time children engage in physical activity during each free play and Zumbini® class were calculated and recorded. All research assistants were trained using the accelerometers before the baseline phase. To capture the physical activity amounts, vector magnitude (VM) was calculated by ActiLife v 6.8.0 software for each data time point from the
3 movement axes using the following equation:

\[ VM = \sqrt{\text{vertical}^2 + \text{mediolateral}^2 + \text{anterioposterior}^2} \]

The sum of the VM in each free play situation or Zumbini® class were recorded as a data point to represent the physical activity amounts. The missing data were omitted. Thus, only available data can yield results (Peng & Chen, 2018). Participants were excluded from analysis if they missed more than 1 free play situation or more than 1 Zumbini® class (i.e. attendance rate dropped below 60%).

**Step 2: Movement counts per minute**

Movement counts per minute (counts/minute) are calculated as a standardized measure of physical activity across baseline and intervention sessions, and across child participants. After accelerometers recorded the movement counts in 3 movement axes, the movement counts were provided in 5 seconds interval. The total movement counts represent the physical activity amounts that the participants preformed in the data collection time. However, the length of the time that each participant engaged in each data collection may not be equal. Comparing the total physical activity amounts performed in different time lengths is not practical. Thus, applying movement counts per minute in comparing the physical activity amount is more concrete in monitoring the physical activity amount changes between sessions. The movement counts per minute were calculated with the following equation for each participant in free play or Zumbini® class:

\[ \text{Movement counts per minute} = \frac{\text{Total movement counts from accelerometers in the session}}{\text{The time length the participants were observed in the session}} \]

**Step 3: NAP**

NAP was conducted to indicate the physical activity differences between baseline and intervention phases, at the child-level. NAP displays differences between phases and is considered a crucial part of visual analysis in single case study designs (Sidman, 1988). The
NAP value represents the probability that a randomly selected data point observed in an intervention phase session will be higher than a given baseline data point (Parker & Vannest, 2009). The NAP value is calculated using the following equation:

\[
\text{NAP value} = \frac{\text{the total possible pairs-the overlap sum}}{\text{the total possible pairs}}.
\]

NAP values range from 0.0 to 1.0, with a 1.0 representing a 100% chance that the participant’s physical activity amounts during the intervention, Zumbini® class, was higher than the physical activity amount during the baseline, free play situation. The thresholds for evaluating effect size of NAP values are as follows: weak effects: 0–0.65, medium effects: 0.66–0.92, and large effects: 0.93–1.0 (Parker & Vannest, 2009). NAP values were reported alongside 90% confidence intervals (CI) for each participant, which is the same as a previous playgroup investigation (Ross et al., 2017).
Chapter 3. Results

Participants

Eleven young children with and without disabilities (9 families) were recruited in this study (mean age=32.13 months, SD= 9.746 months, range= 18-45 months; 4 males). A total of 8 participants (7 families) with complete data collection (at least 4 baseline and 4 intervention sessions) were used for data analysis. Participants included 5 young children without disabilities (mean age=33.2 months, SD= 8.319 months, range= 24-43 months; 2 males) and 3 young children with disabilities (mean age=30.33 months, SD= 13.65 months, range= 18-45 months; 2 males). Two of the participants with disabilities had mobility related disabilities and performed limited motor ability compare to their peers, although the precise amount and type of delay were unknown. Child 008 was diagnosed with spina bifida. He has poor movement function on lower extremities, which results in his dependent on mobility and fair sitting balance. Sitting with position support and playing the toys with upper extremities were the most common activities Child 008 performed during baseline phase. In the intervention phase, he participated in Zumbini® dancing activities by the caregiver’s carrying and holding. While in instruments play and singing, he sat with the caregivers’ support, played the instruments, and swung his body under the assist from the caregiver. Child 009 was diagnoses with cerebral palsy with spasticity quadriplegia and has poor movement ability on upper and lower limbs. He has head control and upper extremity weight bearing ability. In turn, Child 009 could crawl but depend on the caregiver in most object control tasks and locomotion. In baseline phases, he lay down or sat with support on the floor mat and had occasional interaction with the caregivers (mother). In the intervention phase, Child 009 was held and carried by the caregiver during dancing. In instruments play and singing, he could use the instruments and swung his body with the rhythm under the caregiver’s assist. Child 001 had communication disorder, however, could physically participate in both baseline and intervention phases. Demographic characteristics of the participants are displayed in Table 2.
All the participants engaged in each free play and Zumbini ® class together with at least one caregiver. The participants who complete data collection kept attendance rate over 75% in baseline and intervention, with each participant had one time absent in each phase at most. Personal and weekly attendances of the participants are shown in Table 3. Caregivers who participated in this study were family members of the participants. The relationship includes parent-child, grandparent-grandchild, siblings, and cousin. The caregivers and the relationship with the participants are listed in Table 4.

**Physical Activity Amount**

Physical activity amounts of the participants in each session of the baseline (free play session) and the intervention phases (Zumbini® session) and the trend of change are displayed in Table 5. Participants performed more movements on the wrists than on the hips. The physical activity amounts on wrists ranged from 1467.84 counts/min to 14927.05 counts/min. While the physical activity amounts on hips ranged from 96.17 counts/min to 4952.10 counts/min. The change of the movement counts and the trend within each individual were varied. Physical activity amounts in different phases will be described in the following paragraphs:

**Baseline Phase: Free Play Session**

In the baseline phase, physical activity amount of the participants ranged from 1467.84 counts/min to 12045.79 counts/min on wrists and from 583.31 counts/min to 4952.10 counts/min on hips. Participants with mobility delay (Child 008 and Child 009) performed less physical activity amount in each free play in baseline than the participants without mobility delay. The participant with communication disorder (Child 001) performed similar physical activity amounts with other participants without disabilities.

The physical activity performance trend in the baseline phase varied among different participants. In Child 004 and Child 010, the movement counts on wrists and hips increased
through the baseline sessions. However, Child 006 decreased the physical activity amounts through baseline phase. While the other participants (Child 005 and Child 007) displayed a relatively similar trend of physical activity in each baseline session.

**Intervention phase: Zumbini® Session**

In the intervention phase, the physical activity amount that participants performed ranged from 2646.32 counts/min to 14927.05 counts/min on wrists and from 96.17 counts/min to 5083.96 counts/min on hips. In general, participants with mobility delay performed a similar amount of movement counts in the baseline and intervention phases. The participants with communication disorder (Child 001) performed more physical activity amounts in first intervention session with 8524.44 counts/min on wrists and 3242.72 counts/min on hips. She performed an increasing trend on physical activity amounts of hips with 3787.56 counts/min on hips in the last intervention session. However, the physical activity amounts of Child 001 decreased through the intervention phase with 6779.86 counts/min on wrists in the last intervention session. A similar trend of physical activity amount on wrists could be observed on Child 006 and Child 010.

For the participants who increased the physical activity amounts through intervention phase, the trends were different between participants. Child 004 and Child 007 displayed increased trends on physical activity amounts through intervention phase. They both performed the most physical activity amounts on the fifth intervention session.

**Baseline Phase versus Intervention Phase**

The majority of the participants experienced changes in physical activity amounts with medium to large intervention effect (medium: NAP value ranged from 0.66 to 0.93, large: NAP value ranged from 0.94 to 1). Two participants performed significant increasing physical activity amounts on wrists and hips (Child 009 and Child 010). The intervention had large effect on wrists and hips physical activity amounts of Child 009. Using NAP, a large intervention effect
of 1 was calculated for Child 009 (90% CI [0.225, 1]). Child 010 experienced a large intervention effect on wrists and medium intervention effect on hips. Using NAP, a large intervention effect of 1 was calculated for his wrist (90% CI [0.225, 1]) and 0.9167 was calculated for his hips (90% CI [0.058, 1]). The intervention had medium effect on either wrists or hips physical activity amounts of three participants (Child 005, Child 006, and Child 008). Both Child 005 and Child 006 increased their physical activity amounts on their wrists from baseline to intervention phases. Using NAP, medium intervention effect of 0.7778 was calculated for Child 005 (90% CI [-0.282, 1]) and 0.8333 was calculated for Child 006 (90% CI [-0.109, 1]). Child 008, who has been diagnosed as spina bifida and had mobility delay, increased his physical activities on hips from baseline to intervention phases. Using NAP, a medium intervention effect of 0.75 (90% CI [-0.275, 1]) was calculated for Child 008. However, Child 004 performed significant decreasing physical activity amounts on hips from baseline to intervention phase. Using NAP, a weak intervention effect of 0.0833 was calculated for Child 004 (90% CI [-1, -0.058]). Table 6 displays the physical activity amount in every minute in each session, NAP value, and 90% CI in individual level.
### Table 2. Demographic information of the participants

<table>
<thead>
<tr>
<th>Demographics (n=8)</th>
<th>Child 001</th>
<th>Child 004</th>
<th>Child 005</th>
<th>Child 006</th>
<th>Child 007</th>
<th>Child 008</th>
<th>Child 009</th>
<th>Child 010</th>
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<td>Mobility delay (Yes=2, No=6)</td>
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### Table 3. Attendance rate

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<th>Attendance rate (%)</th>
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<th>Baseline 3</th>
<th>Baseline 4</th>
<th>Intervention 1</th>
<th>Intervention 2</th>
<th>Intervention 3</th>
<th>Intervention 4</th>
<th>Intervention 5</th>
<th>Attendance rate (%) Baseline</th>
<th>Attendance rate (%) Intervention</th>
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<td>Baseline 3</td>
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<td>Intervention 1</td>
<td>Intervention 2</td>
<td>Intervention 3</td>
<td>Intervention 5</td>
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Table 5. Physical activity amount (movement counts) of the participants
Table 6. Individual physical activity amounts per minute in every baseline and intervention session, alongside individual NAP value and 90% CI.

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<tr>
<th>Child</th>
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<th>Hip</th>
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</table>

Significant: *p< 0.10, ** p< 0.05

NAP weak intervention effect: NAP value= 0 to 0.65, NAP medium intervention effect: NAP value=0.66 to 0.93, NAP large intervention effect: NAP value=0.94 to 1
Chapter 4. Discussion

The purpose of this study was to determine the effect of Zumbini® on physical activity amount of young children with and without disabilities. The present work is a demonstration of how physical activity behavior of young children with and without disabilities change through family and music factors in Zumbini® classes. The hypothesis of current study is that the young children will be more physically active during the Zumbini® session than during a comparable period of a free play session during an inclusive playgroup. The results partially support this hypothesis. Overall, the change of the participants’ physical activity amounts in this study were varied.

The results show that the effect of Zumbini® could be different on young children with and without disabilities. One of five participants without disabilities (Child 010) had significant change with medium to large intervention effect on physical activity amounts. Two of five participants without disabilities (Child 005 and Child 006) experienced insignificant change with medium intervention effect. One of the five participants without disabilities (Child 004) had significant change with low intervention effect on physical activity amounts. One of the participants without disabilities (Child 007) experienced insignificant change with low intervention effect on physical activity amounts. Among the three participants with disabilities, one out of two participants with mobility delay (Child 009) experienced significant change of physical activity with a large intervention effect. The other participant with mobility delay (Child 008) had an insignificant change of physical activity with a medium intervention effect. While one participant (Child 001), who has communication disorder, experienced an insignificant change of physical activity with a low intervention effect. The reason for the varied physical activity change and the trend in each participant will be explained in the following paragraphs:
Participants without Disabilities

Among the participants without disabilities, three (Child 006, Child 005, and Child 010) out of five experienced a medium to large intervention effect. Two out of five (Child 010 and Child 004) had a significant change in physical activity amounts. While Child 007 did not demonstrate significant changes and medium or large intervention effect in physical activity.

The medium to large effect of Zumbini® in this study on young children without disabilities may be attributable to peers’ interaction under music condition. Child 010 demonstrated a significant change of physical activity amounts and had a lot of interaction with Child 006 in intervention phase. He performed free play behavior and interacted with different participants in baseline phase. However, Child 010 expressed the excitement and performed running and rough and tumble play with Child 006 during intervention phase under music condition. In turn, the trend of the physical activity amounts of Child 010 and Child 006 in intervention phase were similar. The different physical activity behavior could result in the significant difference of physical activity amounts in Child 010. Child 006’s physical activity behavior was triggered by the physical activity behavior of the caregiver (mother) and the peers. He participated in this study with his mother and sister in most of the sessions. According to the field notes from research team members in baseline phase, the mother tended to interact with Child 006 with high intensity physical activity, such as running and jumping. In the intervention phase, he tended to run and had rough and tumble play with another participant (Child 010). Although he received a medium effect intervention on wrists physical activity amounts, the change was not significant due to the similar physical activity behavior in different phases. In sum, peer interaction during the intervention phase results in physical activity changes of the participants without disabilities in current study.
The interpretation of the increasing physical activity amounts of Child 006 and Child 010 is consistent with previous findings, which demonstrated how music affects social interaction and physical activity of young children (Becker, McClelland, Loprinzi, & Trost, 2014; Kirschner & Tomasello, 2010; Rabinowitch & Meltzoff, 2017). In music condition, young children could improve their social bonding and spontaneous cooperative behavior (Kirschner & Tomasello, 2010). In addition, synchronous and asynchronous movement could alter young children’s sharing behavior (Rabinowitch & Meltzoff, 2017). The change of social interaction further increases the physical activity amounts. According to Barkley et al. (2014), young children could perform 54% greater (P < .02) physical activity amounts during the friend condition than during solo play. In the current study, Child 010 experienced a significant medium to large effect on physical activity amounts change due to playing with Child 006, who had high physical activity amounts in both baseline and intervention phases. Therefore, we could infer that Zumbini® in this study changed the young children’s physical activity behavior with improving peer social interaction.

Zumbini® in this study had a medium effect on physical activity amounts change of Child 005 due to her personal preference. She performed an increased trend in physical activity amount change. According to the feedback from the caregiver (mother) in the field notes, Child 005 preformed a preference on Zumbini® songbook bundle. Therefore, the family used the Zumbini® songbook bundle often and played the music at home. In turn, Child 005 could get more familiar and perform more physical activity with the session progress. In turn, the intervention had medium effects on her wrist physical activity amounts. The insignificant change showed data analysis could be the result of limited data points.
There was a low intervention effect, which suggested physical activity decreased from free play (baseline phase) to Zumbini® sessions (intervention phase) for Child 004. According to the field notes, the research team members observed that it took a long time for Child 004 to be involved into a new environment. In the free play situation of the baseline phase, she and the caregiver participated in typical physical activity, such as throwing and kicking ball. In the intervention phase, Child 004 usually stayed around the caregiver and could engage in Zumbini® activities under the guidance and encouragement from the caregiver. Her personal characteristics could make her decrease physical activity amounts through baseline to intervention phase.

**Participants with Disabilities**

Among the participants with disabilities, two out of three (Child 008 and Child 009) experienced medium to large intervention effect. One out of three (Child 009) performed significant physical activity amounts change. While Child 001, who has communication disorder, did not perform a significant change and medium to large intervention effect on physical activity.

Disability type results in different physical activity amounts change on participants with disabilities in the Zumbini® session. The participants with mobility delay stayed with the caregivers (mothers) at the same place in the play space during the baseline phase and were carried and held by the caregiver in the intervention phase. The following paragraphs will explain the reason for the varied physical activity change:

Due to the assist from caregiver, young children with quadriplegia demonstrated a significant change on physical activity amounts. Child 009, who was diagnosed with cerebral palsy, experienced a large intervention effect with a significant change of wrist and hip physical activity amount. In the baseline, he stayed with the caregiver (mother)
at the same place in the play space. Child 009 and had occasional interaction with the caregiver in lie down or prone position. In the intervention phase, Child 009 was carried and held by the caregiver in the Zumbini® activity. In turn, the caregiver’s physical activity assist contributed to the physical activity amounts in each session. The caregiver performed more physical activity behavior than in baseline phase. Therefore, quadriplegia and the assist from the caregiver made the Child 009’s physical activity amount change significantly and demonstrated a large intervention effect.

The young children with poor lower extremities function experienced medium intervention effect due to the caregiver’s assist on mobility. Child 008, who was diagnosed with spina bifida, had movement function on upper limbs but needed assistance in locomotion. In the baseline, Child 008 stayed in the same place in the play space with the caregiver (mother). He played the toy instruments under the caregiver’s supervision most of the time. The caregiver seldom had interactions with Child 008 in baseline phase but provide occasional assist when needed, such as changing diapers and providing instruments. In the intervention phase, Child 008 participated in the Zumbini® classes with the carrying and holding by the caregiver. The caregiver’s movement contributed Child 008’s physical activity amounts on hips in each intervention session. Therefore, Child 008 experienced a medium intervention effect on his hips physical activity amounts because of the assist from the caregiver but had an insignificant change on wrist physical activity amounts due to his good upper extremities function.

Disability was the main reason for the difference in physical activity between participants with and without mobility delay in this study. Different types of disabilities need different assistance for physical activity participation. Participants without mobility delay could participate in physical activity spontaneously. While the
participants with mobility delay needed assistance from the caregiver to engage in physical activity. In turn, their physical activity differences were contributed by the caregivers. The movement counts that accelerometer recorded were the movement from the caregiver instead of the participants.

Physical activity behavior of the participant with communication disorder (Child 001) was similar to the participants without disabilities. The physical activity amounts change was not significant. In the baseline phase, Child 001 had physical interactions with the caregiver and followed the caregiver’s guidance in performing free play behavior, such as playing an instrument, using toys, and playing with scarfs. In the intervention phase, Child 001 expressed the excitement and performed physical activity according to the instructions in the first class of Zumbini® session. However, she did not perform a significant increase in physical activity amounts from the baseline to the intervention phases although following the instruction during Zumbini® classes. The insignificant physical activity change of Child 001 could be attributable to personal preference in different physical activity situation (Frank et al., 2018). According to the field notes, research team members found that Child 001 tended to sit and listen to the singing and talking from the Zumbini® instructor. Her preference to the Zumbini® classes could be the reason for her insignificant change in physical activity amounts.

The interpretation of personal preference affects physical activity amounts change of young children (Child 001 and Child 005) in Zumbini® session is consistent with previous findings. Child 005 experienced a medium effect intervention on physical activity amount. However, the intervention had a low effect on physical activity amounts of Child 001. According to the research from Frank et al (2018), young children who performed more physical activity amounts in free play could express less
physical activity amounts in structured play. Moreover, young children who had less physical activity amounts increased their physical activity in structured play. Frank et al (2018) explained that it is possible there could be aspects of the structured play and free play that positively affected young children’s preference of the conditions but did not positively affect their physical activity amount. Thus, personal preference of young children could influence their physical activity differences under the Zumbini® session.

**Limitations**

There are some limitations in regards to the research design of the current study. First, the accelerometers placed on the participants with mobility delay recorded the physical activity amount of their caregivers instead of the participants because the participants with disabilities were carried and held by the caregivers during Zumbini® sessions. In turn, the actual effect of Zumbini® on physical activity behavior of the young children with mobility delay is still unknown. Second, the length of the intervention in the current study was shorter than recommended for Zumbini®. The Zumbini® program is usually offered between 6-16 weeks. However, we provided Zumbini® for 4 weeks due to the limited academic term of Oregon State University. The shorter intervention length may have influenced the effect of Zumbini®. Third, the suggested maximum class size of Zumbini® classes is 12 to 14 children. However, there were 10 participants in this study and the small sample size makes the results difficult to generalize.

Some limitations resulted from the family environment. First, the participants had different familiarity to Zumbini® music and activity. The Zumbini® songbook bundles were given to the caregivers one week before the intervention phase. However, it was not a requirement that the family needed to use the Zumbini® songbook bundle when at home. The participants could have different familiarity to Zumbini® music and
activities due to different usage between families. Second, different caregivers engaged in data collection sessions and may have influenced the physical activity amounts of the participants. We encouraged the caregivers to participate with their children in free play and Zumbini® sessions. Participation of different caregivers depending upon the week may have influenced physical activity and interactions between caregivers and children. Therefore, the participants’ physical activity amounts could be affected by caregiver-participants interaction instead of Zumbini®.

Finally, the family factors outside of data collection time, such as parenting style, family support, and family physical activity preferences, may have influenced the physical activity amounts of the participants as well. However, the family factors and participants’ physical activity behavior outside of free play and Zumbini® sessions was not measured in the current study. In turn, the reason for the participants’ physical activity change remains not well understood.

**Strengths of this study**

The value of the current study is the demonstration of how a Zumbini® session could change the physical activity behavior of young children. With the suggested lesson plan, music instruments, and class size from Zumbini®, the intervention in this study could be used as a simulation to the general Zumbini® classes. On the other hand, a single subject design was applied in the current research, we included several participants and compared their physical activity amounts between baseline and intervention phase on individual level. The internal validity could increase due to multiple results analysis. This study indicates the situation that could increase young children’s physical activity under a Zumbini® session. Although the physical activity change of the participants was varied, with a small numbers of participants, the research team members could observed the physical activity behavior of the
participants and the caregivers and describe the potential reason for the physical activity changes. In addition, young children with varying disability type and their caregivers were included in this study. The present work also demonstrated the potential physical activity behavior of young children with disabilities in the Zumbini® classes. In sum, the results of this study show the possible effect of a 3 to 4 class Zumbini® session.

**Future Directions**

To fully capture the effect of Zumbini® on young children’s physical activity, future research could increase intervention length and apply more powerful research designs, such as implementation of 6-16 weeks Zumbini® classes in an ABAB single subject design or longitudinal research design. In addition, measuring family factors and participants’ physical activity behavior outside of data collection time could provide more information in regards to their physical activity changes through different study phases. A larger sample size could make research outcomes more generalizable. Therefore, a randomized control trial could be appropriate for concluding the physical activity change of young children under free play compared to Zumbini®. Future research may record the physical activity change of the participants using different measuring methods (e.g., video record observation). This may be especially important for the young children with mobility delay because caregivers assisted their movement and the actual physical activity of these participants needs to be clarified.

**Conclusion**

This study provides a demonstration of how a 3 to 4 weeks Zumbini® session could change physical activity behavior of young children with and without disabilities in an inclusive playgroup. The findings indicate that the physical activity change of young children with and without disabilities between free play situation and Zumbini®
classes were varied. Future research, which includes a larger sample size, longer intervention time, and different measuring methods, will be needed to fully capture the effect of Zumbini® on young children with and without disabilities.
Appendix

Literature Review

General Introduction

Physical activity is important for people. It is defined as the body movement that is produced by skeletal muscle and results in energy expenditure (World Health Organization, n.d.). Physical activity behavior in early childhood is very important because it affects people’s physical activity behavior in adolescent and adulthood (Telama et al., 2014, 2005). Young children who perform more physical activity behavior may participate more in physical activity in school age (Telama et al., 2014) and have a more physically active lifestyle in their adulthood (Telama et al., 2005). In addition, physical activity is related to young children’s multiple health indicators, which includes motor and cognitive development, psychosocial health, bone and skeletal health, and cardiometabolic health (Carson et al., 2017; Pitukcheewanont et al., 2010). Young children with disabilities could improve their body function and decrease the symptoms through participation in physical activity (Casey et al., 2018; Halperin et al., 2013). In short, physical activity plays a crucial role in young children’s development.

However, children tend to have little physical activity (Gubbels et al., 2011; Hnatiuk et al., 2014) and have high obesity rates (de Onis et al., 2010). Young children with disabilities were indicated to have lower physical activity amount than young children without disabilities (National Center on Health, Physical Activity and Disability, n.d.). Therefore, it is necessary to help young children with and without disabilities participate in physical activity to maintain good health. The aim of this appendix is to provide the background of physical activity in young children along with the recent knowledge on increasing their physical activity. The following paragraphs will describe
The Importance of Physical Activity to Young Children with and without Disabilities

Physical activity plays an important role in physical health of young children and contributes to their motor development (Carson et al., 2016). To improve motor development, Adamo et al. (2016) provided a physical activity based training as an intervention to childcare providers to facilitate physical activity of young children. They found that the children in the intervention group had a significant improvement on locomotor skill and object control. Children whose care-provider did not receive the training had a significant decline on object control skills. The time young children spend on physical activity relates to their motor development as well. Children who have better motor skill may find it easier to do physical activities and may engage in more physical activity than the children who has less motor skill (Williams et al., 2008). Children who do not proficiently have fundamental movement skills may have limited prerequisite skills to be physically active and have less opportunities to participate in physical activity (Stodden et al., 2008). Fisher et al. (2005) indicated that habitual physical activity had a significant relationship with young children’s fundamental movement skill. Williams et al. (2008) also found that young children who were in high tertile locomotor performance spent significantly more time on MVPA and vigorous physical activity (VPA) than those children with low tertile locomotor performance. In turn, young children who spent more time on MVPA had more possibility to perform well in fundamental movement skill.
Physical activity could benefit young children in metabolic health, psychosocial health, and bone and skeletal health (Pitukcheewanont et al., 2010; Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003). A previous study found that young children who are overweight are less active than non-overweight young children (Trost et al., 2003). This may further affect the children’s psychosocial health. Children in 0 to 11 years old with obesity were indicated to have a higher possibility of low self-esteem (Wang, Wild, Kipp, Kuhle, & Veugelers, 2009). Lee and Carson (2018) found that children in 0 to 5 years old who engage in physical activity more than 3 hours in one week exhibited high social and interactive skills. In bone and skeletal health, physical activity has been positively associated with bone mineral density in young children (Janz et al., 2001). Among all the environmental factors for the children’s skeletal health, physical activity was indicated to be the most influential contributor to peak bone mass (Pitukcheewanont et al., 2010). A study found that in young children from 4 to 6 years of age, those with more physically active had greater bone mass (Janz et al., 2001). In sum, young children can be benefit from physical activity in preventing overweight, increase psychosocial health, and increase bone density.

Physical activity is also associated with young children’s cognitive function (Carson et al., 2016; Draper, Achmat, Forbes, & Lambert, 2012). Cognition is defined as the processing of information from external and internal input (Neisser, 1967). The process includes transform, reduced, elaborated, stored, recovered, and used. Therefore, it involves many kinds of function, including attention, executive function, and memory. Physical activity can cause more oxygen and glucose to be transported to the brain and can lead to better cognitive performance (Marmeleira, 2013). Physical activity was indicated to provide improvement on intelligence and academic achievement of young children (Mavilidi, Okely, Chandler, Cliff, & Paas, 2015).
Particularly, the effect of physical activity on attention ability and executive function of young children has been addressed in previous researches.

Both attention and executive function of young children could be improved with physical activity. Attention refers to choosing and concentrating on specific information (CogniFit, 2018). It requires a person to focus on relevant stimuli and ignore other perceivable information. Previous studies indicated that physical activity could improve young children’s attention. Physical activity with active play had positive association with children’s academic performance and self-regulation, which need attention ability (Becker, McClelland, Loprinzi, & Trost, 2014). Palmer et al. (2013) found that children who participated in physical activity before attention ability tests had better performance than those children who did sedentary activity before the tests. Executive function is a high level mental process of applying information to produce behavior (Yoge, Hausdorff, & Giladi, 2008). It includes cognition and behavior, which is necessary in goal-directed action. Xiong et al. (2017) compared young children’s executive performance under structured physical activity and free-activity and found that those participants in structured physical activity had better performance in executive function. However, the improvement of executive function depended on the children’s attention, the context, and the duration of physical activity (Willoughby, Wylie, & Catellier, 2018). Different contexts or activities may have different social or cognitive demands and may limit or activate the benefit of MVPA. It may also display negative association between executive function and MVPA. Willoughby et al. (2018) suggested that characterizing the sample with respect to children’s hyperactive-impulsive behaviors and measuring the context that children engage in MVPA should be considered when applying the research about the relationship of physical activity and cognitive function. In short, providing appropriate
physical activity according to young children’s ability can benefit them in attention and executive function.

Young children with disabilities can benefit from participating in physical activity as well. Physical activity not only can help children with disabilities in improving physical health and cognitive development (Carson et al., 2016) but also can improve the body function and help them achieve their treatment goals (Halperin et al., 2013; Valentin-Gudiol et al., 2013). Young children with Down syndrome were indicated to have improvement on increasing development of independent walking from treadmill training (Valentin-Gudiol et al. 2013). The improvement includes step length, gaits, and walking speed. Halperin et al. (2013) provided an 8-week physical activity session for young children with Attention-Deficit/Hyperactivity Disorder Symptoms (ADHD). They found that physical activity could decrease their severity of ADHD symptom. Furthermore, the effect had persistence for 3 months. Casey et al. (2018) used a 12 week, 5 hours walking session on 4 year old children with Pitt Hopkins syndrome (PTHS). After the sessions, they found that the participant could exceed the parents’ and caregivers’ expectation on social interaction, physical activity and physical health. In brief, physical activity not only benefits young children with disabilities in improving health but also help them in development and body function and remediating their symptom.

**Physical Activity Participation of Young Children with and without Disabilities**

Young children do not have sufficient physical activity amount to keep themselves healthy. They are recommended to be physically active at least 120 to 180 minutes every day and spend 90 to 120 minutes on MVPA every 8 hours a day (American Academy of Pediatrics et al., 2011; NHS, 2018). The prevalence rate for young children who meet the guideline of 120 minutes daily of MVPA was 0.0% to 95.7% (Beets et al.,
The range of the prevalence is broad and indicated the importance of the interpretation of the guideline and the selection of appropriate measurement.

According to the U.S. Department of Health and Human Services (2018), young children ages 3 through 5 years should be physically active throughout the day. Adult caregivers should encourage their active play that includes a variety of activity types. However, the physical activity guidelines for children under 3 years old is not well defined. Institute of Medicine (IOM) suggested that childcare centers provide opportunities for light, moderate, and vigorous physical activity for young children at least 15 minutes per hour (Institute of Medicine, 2011). In the investigation from Pate et al., there were about one half of young children who did not meet the guideline from IOM (Pate et al., 2015). However, previous studies reported that young children had little physical activity (Gubbels et al., 2011; Hnatiuk et al., 2014). Motionless and stationary with limb and trunk movements were the most frequent observation intervals for young children in preschools (80.6% to 87.5%) (Brown et al., 2006). There are about 5.5% of the indoor activity and 21.3% of the outdoor activity were classified as MVPA in young children’s lives (Gubbels et al., 2011). Moreover, young children spend only 2% to 41% of their time on MVPA, which is less than sedentary physical activity (34% to 94%) and light-intensity physical activity (4% to 33%) (Hnatiuk et al., 2014). The physical activity level depends on the pattern and the environment of the activity (McKenzie et al., 1997; Pellegrini & Smith, 1998). In children care settings, children (3 -5 years of age) spend 6% of the time on MVPA (Sugiyama et al., 2012). Moreover, lower child–staff ratios in care center and indoor gross motor activity is associated with MVPA because staffs could provide stimuli or opportunities to the children to be active. Therefore, interventions are important to promote physical activity amount in young children.
Young children with disabilities have less physical activity than young children without disabilities. The physical activity rate of young children with disabilities is unknown. However, previous investigations have indicated that children under 18 years old and with disabilities have restricted participation in physical activity in their daily lives due to the barriers in participating in physical activity (Shields et al., 2011). It may be caused by personal, social, environmental, policy, program-related factors. With the restriction of engagement in physical activity, young children with disabilities tended to have less physical activity than young children without disabilities (NCHPAD, n.d.). It was reported that children under 18 years old, who are with chronic disease and disabilities, seldom had opportunities for participating in fitness and activity programs, such as leisure, recreation, and competition (Newacheck et al., 1998). According to the U.S. National Survey of Children with Special Health Care Needs, there were 65.6% of the responses indicated that the health condition of the children with disabilities affects their daily activities (Data Rescource Center for Child & Adolescent Health, n.d.). A previous study showed that compared to young children without disabilities (M=2.79, SD=0.50), young children with disabilities (M=2.13, SD=0.71) perform less physical activity demand to the environment (Benjamin et al., 2017).

In sum, an inclusive physical activity program is needed to increase the physical activity amount of young children with disabilities.

Environment Influences the Type of Physical Activity that Young Children Participate In

The type of physical activity that young children participate in depends on the environment. Play can help infants develop motor control function and increase the physical activity level of preschoolers (Center of excellence for early childhood development, 2011). Moreover, active play is also beneficial to the cognitive
development of young children and could maintain parent-children bond (Burdette & Whitaker, 2005; Ginsburg, 2007). Play is suggested to be an important activity for young children and can be classified into two forms: free play (unstructured play) and structured play (Playgroup centre, n.d.). Pate et al. (2014) compared the difference of physical activity amount of young children in Montessori education, which claims to provide self-chosen and self-directed free play, and traditional preschools. They found that children in Montessori preschool (7.7 min/hr) had more MVPA than children in traditional preschools (6.5 min/hr). Previous study found that young children perform more MVPA during free play (7.7 min/hr) than in structured play (6.5 min/hr) (Frank et al., 2018; Pate et al., 2014). However, young children who were the most active in free play (1970 ± 647 counts/min) decreased their activity during structured play (1462 ± 535 counts/min). Children who were the least (530 ± 239 counts/min) to moderately (1031 ± 112 counts/min) active in free play situations increased activity during structured play (the least active 1313 ± 413 counts/min, moderately active: 1383 ± 345 counts/min) (Frank et al., 2018). In brief, physical activity participation of young children could be influenced by free play and structured play environments.

Young children with disabilities have different hobbies and patterns from children without disabilities in participating in physical activities and need assistance when engaging in physical activity. The pattern of physical activity that young children with disabilities engage in were different according to their disabilities. They were more likely than their typical developing peers to engage in one on one activity with adult (Brown et al., 1999). A previous study indicated that young children with intellectual disabilities were better engaged in routine activities (Kishida & Kemp, 2006). While in the investigation of Ketcheson et al. (2018), children with ASD in 2 to 5 years old (13.22 ± 4.52 %) spent more time on MVPA than their typical development peers did (9.00 ±
3.20%). However, they had significantly poorer motor quotation on gross motor and find motor when compared with typical development young children. Therefore, more instruction and structural environments are needed when providing physical activity to young children with disabilities.

**The Factors could Increase Physical Activity of Young Children**

To increase the physical activity amount of young children, previous research suggested that family and music are two important factors (Murrock & Higgins, 2009; Zecevic, Tremblay, Lovsin, & Michel, 2010). The following paragraphs will explain how family and music improve young children’s physical activity participation.

**Family**

Family plays a crucial role in young children’s physical activity participation. Previous researchers indicated that parents’ overweight, physical activity level, and family risk of obesity are correlate to children’s physical activity level (Klesges et al., 1990; Moore et al., 1991). Recent studies tend to investigate the relation of parents’ behavior and their young children’s physical activity (Oliver et al., 2010; Xu et al., 2015). In general, young children may increase their physical activity if their parents were involved with the physical activity program (Zecevic et al., 2010). There are different kinds of methods that involve family into children’s physical activity. The encouragement and support, which includes helping children in transportation and supervising their activity, from parents could increase children’s physical activity (Xu et al., 2015). Young children who receive more support from their parent have a higher possibility to have at least one hour of daily physical activity (Zecevic et al., 2010). In addition, parents’ lifestyle could affect children’s physical activity. Xu et al. (2015) found that improving parenting practices or changing parenting style might be an approach to increase physical activity time on young children. Oliver et al. (2010)
further indicated that parents’ physical activity rate is associated with the children’s physical activity rate. Therefore, encouraging caregivers to participate in physical activity with the young children in a positive atmosphere may have the potential to increase the physical activity amount of the children.

Previous studies indicated that family-based physical activity could have positive effects on the health of young children with obesity. It improved their health behavior, decreased the obesity rate, and controlled the body mass index (BMI) (Davison et al., 2013; O’Dwyer et al., 2012; Quattrin et al., 2017). Most of the family-based physical activity interventions were applied on improving health of young children with obesity and have positive effect. Family-based physical activity program can be efficient in improving health behavior and weight outcome of young children. A Communities for Healthy Living (CHL) program, which included family co-participation in physical activity, could significantly improve the obesity rate, light physical activity, daily TV viewing, and dietary intake of young children (Davison et al., 2013). O’Dwyer et al. (2012) provided a 10-week family focused active play and parent educational workshop as the intervention to increase child physical activity and found that their sedentary time had positive changes and total physical activity level was increased. Furthermore, the effect was on not only the children but also the family. For both parents and children with obesity problems, family-based behavioral treatment (FBT) could have more efficient than information control (IC) (Quattrin et al., 2017). After a 24 months intervention, Quattrin et al.(2017) found that the BMI of the preschoolers in FBT decrease while the BMI of the children in IC increase. The parent in FBT decreased more weight than in the parents in IC. Therefore, family factors could be a facilitator for improving the physical activity of young children. A previous researcher investigated the efficiency of a family-based intervention material on young children
and their families. It indicated that 52% of parents agreed that the family-based intervention increased the physical activity of their families (Bellows et al., 2011). To sum up, family-based interventions could improve the health condition of young children and their families and increase the physical activity amount.

In young children with disabilities, family support can influence the participation in physical activity as well. The effort and support the family pay on the children with disabilities was indicated to be important in initiating and maintaining their involvement in physical activities (King et al., 2003). Family could provide a deep understanding of the participation in physical activity of the young children with disabilities (Murphy & Carbone, 2008). In turn, involving the family of young children with disabilities in physical activities could increase the physical activity amount of the children due to the exclusion of the condition that may limit their participation, such as injury, preference, and current health status. In addition, family could improve the motor skill learning of young children with disabilities. Hamilton et al. (1999) provided an 8-week parent-assisted motor skill intervention program on young children with disabilities from 3 to 5 years old. They found that the participants who received the instruction from the parents (12.06 in standard score) had a better performance on object-control tests than those participants who did not receive the instruction from the parents (5.00 in standard score) in Test of Gross Motor Development (TGMD). Therefore, family factor could also benefit young children with disabilities in physical activity.

**Music**

Music is also a factor in increasing the physical activity amount of young children. Previous researchers showed the effect of music on health (Murrock & Higgins, 2009). In general, an individual’s psychological and physiological responses to music are
beneficial to their health outcomes (Murrock & Higgins, 2009). In the psychological response, music can alter mood and encouraging social interaction. The auditory distraction provided by music help people distract the attention from the unpleasant feeling during exercise to preference music. Additionally, music helps people express feelings and communicate with others based on cultural experiences and expectations.

In the physiological perspective, music can be the cue to movement and initiate and maintain the physical activity (Murrock & Higgins, 2009). When hearing metrical music, an individual’s left frontal cortex, left parietal cortex, and right cerebellum are active (Tramo, 2001). In processing musical stimuli, right auditory cortex, which is located in superior temporal lobe, is crucial for perceiving musical sound. Neural impulse from auditory cortex stimulates the neural motor impulse and results in the auditory motor entrainment (Murrock & Higgins, 2009). In turn, music has the potential to improve young children’s motivation in participating in physical activity.

Although the specific mechanism of how music influences physical activity participation of young children is unknown, previous researchers have shown the effects of music on physical activity of young children by addressing rhythm exercise. Rhythm is the first element of music. It refers to the recurring pattern and predictable cues to movement (Murrock & Higgins, 2009). Different from general physical activities, rhythm exercise is consisted of movement and music, which is consider to be the factor that increase people’s motivation in participating physical activity (Murrock & Higgins, 2009). When an individual hears of a preferred tempo, the premotor activity would increase and facilitates the tuning-in to the beat (Kornysheva, von Cramon, Jacobsen, & Schubotz, 2010). Therefore, synchronizing music with physical activity could have a positive effect on performance. Brown et al. (2009) indicated that indoor music activity could result in higher level of physical activity on young children. We can conclude that
the rhythm in music plays an important role in improving physical activity in young children.

Dance was indicated to have positive effects on young children’s health in previous studies as well. In dancing, an individual needs to listen to the music, follow the beat, and make and adjust the movement accordingly. Dance requires a person to listen to music and make movement according to the culture and the meaning of the music (Boyd, 2004). Previous studies indicated that dance has the benefit of bodily strength, flexibility, endurance, coordination, concentration, memory, problem-solving, and social skill on young children (Faber, 2017; Lobo & Winsler, 2006). The research about dance in young children tended to investigate the efficiency of reducing obesity, which is related to physical activity level. Mo-suwan et al. (1998) provided a 29.6 weeks aerobic dance program to young children to reduce their obesity problems. They found that the prevalence of obesity in those children who participated in exercise program reduced from 12.2% to 8.8 % compare to the children in control group (11.7% to 9.7%). In sum, dancing could be the activity that increase the physical activity and improve the physical and mental development of young children with music.

Music has the potential to be the cue for movement for young children with disabilities. Most research addressed on the effects of music on physical activity performance on children over 5 years old. With the rhythm in music, children with disabilities could easily synchronize the movement to the beat. It has been applied to improve the movement for children with disabilities in rehabilitative intervention (Coleman, 2017). Children with disabilities could maximize their movement through music activity (Coleman, 2017). In addition, music can improve the motor performance of young children with disabilities. Kwak (2007) used rhythmic auditory stimulation (RAS) for children with spastic CP from 6 to 20 years old in gait training. They found
that RAS with verbal instruction provide the best effect on stride length for ambulation. However, the design of the training application, the effectiveness of RAS, and the expected benefits from the training depend on individual characteristics, such as cognitive ability, physical ability, and family support. The result from previous studied provided the support for including music into physical activity could increase the physical activity and movement quality of young children with disabilities.

Family and music are two important factors in increasing physical activity of young children with and without disabilities. Therefore, providing an inclusive physical activity program that combine family and music factors to improve physical activity amount of young children is necessary. Zumbini® is a family- and music-based physical activity program, may has the potential to increase physical activity amount of young children.

**Zumbini®**

Zumbini® is a 45-minute family-based, structured physical activity program that was created by Zumba® fitness and BabyFirst TV. It is designed for 0 to 4 years old children and their caregivers and incorporates music to encourage movement. The classes are offered in quarterly sessions and once a week, which ranges between 6-16 weeks per session. In every Zumbini® class, 11 to 14 songs, which are based on the Zumbini® songbook bundles, are provided to the young children and the caregivers. There are four kinds of Zumbini® songbook bundles, which are “Hili And The Dance”, “Kalino Finds The music music”, “No Way, Jose!”, and “TJ And His Pjs”. Each Zumbini® songbook bundle includes 20 songs on Zumbini® app and CD, songbook, and a plush toy. Instructors apply one of the songbook bundles to the session and use the music and the lesson plan to lead the classes. Dance, sing, and instrument play are arranged alternatively into the classes according to the lesson plan that are suggested by a
Zumbini® instructor training manual (Zumba Fitness, 2016). The music instruments used in Zumbini® classes includes wrist bells, Bongo drums, rhythm sticks, and egg shakers. Scarfs are applied in the classes to encouraged one of the dances and play peek-a-boo. Before the session start, every family receives a Zumbini® songbook bundle. They could listen to the music that will be provided in the class and watch the music video in APP. The family factor in Zumbini® is that the caregivers dance and interact with the children in classes. The music factor in Zumbini® is that the caregivers and the young children are provided with 11 to 14 songs and are encouraged to engage in physical activity and sing together in class. In addition, the family can use the bundle to enjoy the music and dance at home. Therefore, it is claimed that Zumbini® can benefit children in cognitive skill, balance and rhythm, social skill, emotional development, and bone structure. Zumbini® can be expected to increase the physical activity of young children due to its incorporation of family and music into the program to facilitate rhythm exercise and dance. With the characteristic of music and dance, we assumed that Zumbini® can increase children’s physical activity amount. To our knowledge, this study is the first investigation of the effect of Zumbini® on young children.
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