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Title: The Effect of Indoor Aquatic Activities on Health Patterns of the College Student

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Purpose

The major purpose of this study was to investigate the effects of indoor aquatic activities on the health patterns of the college student. Three groups of students were used in the investigation: the experimental group, comprised of students enrolled in aquatic activities, and two control groups, the first comprised of students enrolled in the physically active sports, and the second comprised of students enrolled in the inactive sports, commonly called leisure activities. Several hypotheses were examined to determine if there was (1) a difference in absenteeism between the groups, (2) a sex difference in absenteeism between the activities, (3) a difference in absenteeism between students using two separate pools, and (4) a psychological attitude difference between the groups as to how they perceived their health status.

Procedure

The study population consisted of 763 male and female students enrolled in the indoor physical education activities at Oregon State University during the winter and spring quarters of 1975.

Each class was observed twice during each quarter and asked to participate in the study. Demographic data was obtained on the first visit, along with students' identification numbers. In the spring quarter, The California Psychological Inventory (CPI) Sense of Wellbeing (Wb) scale was administered to all students participating in the study. A second questionnaire was filled out if the student had been absent due to illness. This questionnaire included the reasons for being absent. The absence questionnaire was administered on the last visit. The demographic information and reasons for illness were tabulated and presented in tables. The absence scores and CPI Sense of Wellbeing scores were tabulated and subjected to one- and two-way analysis of variance fixed category designs.

Findings

1. There was no significant difference in illness between the three groups of activities.

2. Females had a significantly higher rate of absenteeism than males.

3. Respiratory illness was the leading cause of absenteeism due to illness.

4. There was no significant difference between the three groups with respect to their perceived health status.

Discussion of the findings include suggestions for study replications in outdoor aquatic activities, as well as a comparison between indoor and outdoor aquatic activities. Consideration is given to further study of health attitudes, especially between males and females. Implications indicate further study is required into behavioral aspects as a cause of environmental deficiencies before more stringent legal requirements are imposed.

The Effect of Indoor Aquatic Activities on Health Patterns of the College Student

by

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I. INTRODUCTION

The purpose of this study was to investigate the effect of aquatic activities on the illness patterns of the college student. If there is an increased illness rate in students who participate in aquatic activities, then such activities may be contraindicated for both the school physical education and recreational programs.

Historically, researchers have assumed that there is a direct connection between an increase in illness and the use of swimming pools, and that the genesis of these illnesses is the physical, chemical, thermal, and bacteriological characteristics of the water and the swimming environment. However, recent investigators have questioned this direct relationship and have emphasized the need for further study (Lackey, 1953; Lehr, 1954; Amies, 1956; Dick, et al., 1960; Robinton and Mood, 1966; and Task Force on Research Needs, 1970).

Other researchers have emphasized the need for adequate education of sanitarians and pool operators as an important aspect in disease control within the aquatic environment. These studies indicate that properly operated pools should not increase illness among swimmers (Fish, 1969; Dwell, et al., 1974; Clepper, 1975; McCausland and Cox, 1975; and Coleman, 1975). At the present time, there is insufficient information and much confusion in the literature as to the association between aquatic activities and illness.

Background

In 1923 Taylor observed that there was an increase in aural infections, which he related to the increase in the popularity of swimming. He concluded from his observations that prolonged chilling of the body surfaces from swimming lowered resistance. The lowered resistance made the individual more susceptible to pathogenic organisms that might be present in the pool or in the upper respiratory tract. Taylor, in a second study in 1925, reiterated the chilling effect as a major factor in the etiology of otorhinologic conditions and emphasized man's lack of adaptation to aquatic environments. He minimized the significance of water quality as a cause of disease, and maintained that the lowered resistance of the body was the cause of aural disease.

Cohen (1923) and Welty (1923) supported Taylor's observations on the chilling effect and strongly de-emphasized the quality of water as a factor in transmission of disease. These two authors concluded that infections were caused by bacteria already present in the individual and the water provided a medium to carry the bacteria deeper into sinuses. Finck (1927), Taylor and Dyrenforth (1938), Taylor (1939), Mezz (1940), and Maxwell (1941) continued to support the theory of self infection from swimming.

Hasty (1927) continued with the theory of swimming as being the direct cause of illness, but for a different reason. He theorized from observations and experimental work on swimming pools and guinea pigs that the swimming pool water, contaminated by swimmers, was responsible for upper respiratory infections. Cullom (1927) supported Hasty, stating, "I do not believe that any pool can be kept clean."

Humphrey and Ferinden (1948), in a study of upper respiratory infections in three hundred male high school swimmers, found a lower incidence of respiratory infection. This led them to conclude that participation in aquatic activities helped to develop resistance to colds. However, Gallagher (1948) studied the illness rates in a boys' school and concluded that there was a higher incidence rate of respiratory illness, but added caution in interpreting the results.

A study by Staton (1952) on the effect of swimming as an etiological factor in otorhinologic conditions in college men resulted in no significant increase in infection. He also concluded that resistance to ear, nose, throat, or sinus infections is not altered by aquatic activities.

Another study was conducted on the health patterns of swimmers by Stevenson (1953). The results reached by this investigation led Stevenson to state, ". . . an appreciably higher overall illness incidence may be expected in the swimming group over that of the nonswimmer group regardless of the bathing water quality." (1953: 537) He concluded by recommending lowering of water quality standards for fresh water swimming areas. Lackey (1953), reacting to this study, recommended further investigation before lowering the water quality standards.

Amies (1956) and Dick, et al. (1960) pointed out from their research as well as others' that there is a "general opinion" that users of swimming pools have increased illness. They cited the need for further study, along with other researchers in the field (Lehr, 1954; Robinton and Mood, 1966; and Task Force on Research Needs, 1970).

During the last ten years, researchers have studied specific etiological agents as the cause of disease in the swimming environment. The results of these investigations have led some researchers to recommend changes in the standards of swimming pool construction, operations, disinfection, and methods of testing (Favero, et al., 1964; Robinton and Mood, 1966; Hoadley and Knight, 1975; Zsoldos, 1975; and "Report on the National Environmental Health Association Workshop in Swimming Pool Sanitation," 1975).

Other investigators have arrived at different conclusions. They think improperly operated pools are the major cause of illness (Fish, 1969; Paul, 1972; and McCausland and Cox, 1975). Donald Wright, President of The National Swimming Pool Institute, was quoted as saying, "We have no conclusive evidence that in a properly treated pool, diseases are a problem" (Coleman, 1975:449). Eric Mood (Pool News, 1975:8) stated, "Most disease outbreaks associated with swimming involve natural bodies of fresh water, not pools."

There is confusion in the field of swimming pool research as to the relationship of swimming pools and disease. If the assumption of some researchers is correct, that aquatic activities increase illness, there could be a considerable effect on the health of students throughout the nation.

The health of students has been a major concern of educators and health officials for the last century. This concern has led to the development of school health programs. These programs began in the early 1900s, when the first school nurses were appointed in Boston, Massachusetts. Shortly after that, laws appeared in New York State requiring students to have an annual physical examination and inspection for communicable diseases (Randall, 1971).

Disease transmission can take place in the school environment through direct contact with an infected person or through indirect contact with contaminated objects. Once a student becomes infected, the disease usually progresses through several stages. This progression, even though the disease may be mild, can affect the student's learning ability.

Several researchers have investigated the cause of absenteeism in school due to illness. These studies have concentrated on the total school population and environment. The results indicate that respiratory illnesses are the major cause of absences (Evans, 1957 and 1962; Rogers and Reese, 1965; and Basco, et al., 1972). However, there is evidence that specific areas or environments can lead to increased illness.

The swimming pool environment is a special environment. Many schools throughout the United States have swimming pools which are used throughout the year. These pools are used for a variety of aquatic activities. If there is an increase in illness among swimmers, then there is a direct relationship to the total school environment. The concern is not only with the individual swimmers, but with the entire student body because of the possibility of disease transmission from swimmers to other students.

The Problem

The central problem in this investigation was to investigate the effect of aquatic activities on the health patterns of college students. The assumption made by several investigators is that certain diseases are more prevalent in swimmers (Taylor, 1923, 1939; Hasty, 1927; Mezz, 1940; Maxwell, 1941; Gallagher, 1948; Stevenson, 1953; and Hoadley and Knight, 1975). Other researchers have refrained from making direct assumptions and have cited the need for further research (Lackey, 1953; Lehr, 1954; Amies, 1956; Dick, et al., 1960;

Robinton and Mood, 1966; Task Force on Research Needs, 1970; and Coleman, 1975).

The lack of unanimity among researchers provides the basic question: Is there an association between swimming and increased illness? If the assumption of increased illness due to swimming is correct, then swimming could be contraindicated, both in the schools' physical education programs and as a recreational activity.

Statement of the Problem

The basic question to be answered by this study was, "Does the indoor swimming environment affect the health patterns of the college student?" Oregon State University students and facilities were used for this study, which took place during the winter and spring quarters of 1975. Two pools were used in the study--the Women's Building pool and the Langton Hall pool. Three groups of students were used: (1) students who were enrolled in aquatic activities, (2) students who were enrolled in physical active sports other than aquatics, and (3) students who were enrolled in the inactive sports, commonly called leisure activities. The following hypotheses were tested:

Hypothesis I: There is no significant difference in the amount of absenteeism due to illness between students who participate in aquatic sports and those who participate in other sports.

<u>Hypothesis II</u>: There is no significant difference in the amount of absenteeism due to illness between male and female students.

<u>Hypothesis III</u>: There is no significant difference in the amount of absenteeism due to illness between male and female students who participate in aquatic sports.

<u>Hypothesis IV</u>: There is no significant difference in the amount of absenteeism due to illness between students who use the Women's Building pool and those who use the Langton Hall pool.

<u>Hypothesis V</u>: There is no significant difference in the amount of absenteeism due to illness between students enrolled in aquatic sports during the winter quarter and those enrolled in the spring quarter.

<u>Hypothesis VI</u>: There is no significant difference in perception of physical health status among students who are enrolled in a variety of indoor physical education classes as measured by <u>The California Psychological Inventory Sense of Wellbeing</u> scale.

Subsidiary to these six hypotheses are questions dealing with physical measurements and testing of the swimming pools and swimming pool environment. Also, there are questions dealing with types of illness and age group of the students. Although hypotheses are not offered here, findings of the exploration have been reported and incorporated into the results and discussion chapters.

Delimitations

The following factors should be taken into consideration before generalizations are made from this study:

1. The population sample was comprised of students enrolled in physical education classes at Oregon State University during the winter and spring quarters of 1975.
2. All of the physical education class activities were on the OSU campus and indoors.
3. The study was limited to absences due to illness that occurred during the class period.
4. Absences due to illness were reported by the students on a questionnaire form (Appendix A).
5. The California Psychological Inventory Sense of Wellbeing (WB) scale was used to measure the students' perception of their health status.

Theoretical Framework

In addition to the main problem of the effect of aquatic activities on health, an attempt will be made to provide insight to broader theoretical and philosophical questions. These questions deal with education of the sanitarian and the pool operator, as well as the assumptions regarding maintenance of pool (water) quality standards or requirements.

Until recently, education on swimming pool maintenance and operation has not been considered as a factor in illness associated with swimming pools. Education does play an important part in prevention of disease and could be a contributing factor in illness associated with the aquatic environment. Two individuals share the responsibility of preventing illness in the aquatic environment: the health official (sanitarian) and the individual who maintains and operates the swimming pool.

The sanitarians have been principally concerned with achieving and maintaining legal standards relating to swimming areas. The foundation of their practice has been surveillance and code enforcement. Corrections made as a result of legal action, however, are often minimal and temporary, requiring repetitive visits by the sanitarian to assure compliance. This practice does not contribute to the sanitarian's ability to deal with people as a cause of environmental problems. Law enforcement is necessary to avert immediate catastrophes; however, it should not be substituted for the educational approach (Goldsmith, 1972).

The individual who maintains the swimming pool and environment could be the most important factor in prevention of illness. The need for education of swimming pool operators is becoming a major concern in prevention of disease from the aquatic environment (Fish, 1969; Dwell, et al., 1974; Clepper, 1975; McCausland and Cox, 1975; and Coleman, 1975).

More stringent regulations, modernization of old equipment, twenty-four-hour filtration, and better measurement techniques are methods advocated by some authorities for controlling disease in the aquatic environment.

Summary

The object of this study was to investigate the effect of aquatic activities on illness patterns of the college student. Historically, researchers have assumed a direct connection between increased illness and use of swimming pools. Recent investigators have questioned this direct relationship and emphasize the need for further study. Physical, bacteriological, chemical, and thermal characteristics of the water and swimming environment play an important part in disease transmission. The importance of these factors have caused the establishment of laws for public protection. Enforcement of these laws is the prime responsibility of the sanitarian, both through legal action and education of the pool operator.

II. REVIEW OF LITERATURE

The problem posed in this study indicated the necessity for research and review of the literature in several areas. The first was the aquatic environment as related to disease transmission, including the bacteriological and chemical aspects, and maintenance of proper standards. The second was the leading reasons for absenteeism in schools. The third was related studies, showing a similar study basis and content. The fourth was recent trends, to indicate comparatively new areas of study into the causes of increased illness for swimmers.

Aquatic activity is an integral part of the physical education programs of many schools. The aquatic environment is special, with problems and hazards not found in other areas of the school environment. The possibility of disease transmission within the facilities of this environment has been of concern to educators and health officials.

Aquatic Environment

There is a general assumption on the part of some researchers that swimming is a predisposing factor in the transmission of diseases. However, scientific evidence is extremely scarce, and authorities have cited the need for further study (Lackey, 1953; Lehr, 1954; Amies, 1956; Dick, et al., 1960; Robinton and Mood, 1966; and Task Force on Research Needs, 1970).

Public health officials and legislative officials, recognizing the possibility of disease transmission in swimming pools, have set minimum standards for construction and maintenance of swimming pool operations. Both Oregon (1959) and California (1968) have followed these guidelines and enacted laws governing swimming pools. The American Public Health Association has also made recommendations on pool standards and designed a model ordinance (Joint Committee on Swimming Pools, 1964). These laws provide minimum standards for building, maintaining and operating swimming pools used for public bathing. There are two critical areas covered in the laws, bacteriological and chemical, each having specific standards.

Bacteriological

The testing for bacteria in a swimming pool relies on the coliform group. These bacteria are nonpathogenic and their presence in the water is used as an indicator of possible pollution. Traditionally, the coliform tests have been used for detection of pollution in domestic water supplies (United States Public Health Service Drinking Water Standards, 1962), and the same methods are used for the testing of swimming pools (Taras, et al., 1971).

The standards set by the American Public Health Association (1964), the *Oregon Administrative Rules* (1971), and the *California Administrative Code* (1969) require that not more than fifteen percent of the pool samples collected over any considerable time shall show positive confirmed tests in any of the five ten-milliliter portions examined for coliform organisms. If there are more than the prescribed maximum number of coliform organisms present, there is a possibility of pathogenic organisms being present in the water.

Pathogenic micro-organisms are the single most important contaminant in the swimming pool. Renn (1972) stated that bacteria tend to behave as large organic molecules and seek out and attach themselves to the interfaces of the swimming pools. Interfaces include not only the walls and bottom of the pool, but piping, filter media, pumps, gaskets, and filtration tanks. The effect is that the bacteria move to the edges along with organic material, forming strong bonds with one another. As the bacteria attach to the interfaces, they build up a slimy capsule around themselves and disinfection becomes increasingly difficult.

Removal and destruction of micro-organisms is an important aspect of any pool operation. In some studies, faulty pool operation is cited as the cause of transmission of the disease. Foy, et al. (1968), reported an outbreak of adenovirus type 3, which caused pharyngoconjunctival fever, in two swimming teams after exposure to swimming pool water which had received improper chlorination. The Department of Health in Saint Paul, Minnesota, in April, 1972, investigated an outbreak of skin infections among sixty persons using a hotel whirlpool and adjacent facilities. After a complete evaluation and laboratory analysis by the Center for Disease Control in Atlanta, Georgia, Pseudomonas aeruginosa was confirmed as the cause of the outbreak. The transmission of the infection was attributed to inadequate disinfection of the whirlpool.

Palmquist and Jankow (1973) isolated Pseudomonas aeruginosa and other members of the Pseudomonas genus in pool water as a result of an outbreak of otitis externa in June, 1966, in Colorado. At the time of isolation, the chlorine and coliform tests were within required standards. However, Palmquist did not cite the actual test results.

Several researchers have isolated pathogenic bacteria and virus from swimming pool water when the coliform tests were considered satisfactory. The standard method of testing for pollution of swimming pool water has been under considerable attack.

Favero, et al. (1964), suggested that staphylococci be adopted as indicators of pool water pollution. They found that, while coliform was an indicator of intestinal bacteria pollution in pools, there were also large numbers of staphylococci present. During the tests, staphylococci were frequently found when no coliform bacteria were present. Because of this research, the authors concluded that the presence of staphylococci should be considered a valid indicator of pollution derived from mouth, nose, throat, and skin secretions. Staphylococci is also more resistant to chlorine than coliform, and therefore, it is felt that the absence of large numbers of staphylococci would indicate absence of intestinal bacteria.

Robinton and Mood (1966) in a limited studyon female swimmers indicated that the majority of the subjects contributed coliform organisms to the test water. They concluded, therefore, that coliform bacteria should continually be used as indicators of pollution. The study also revealed that staphylococci are shed in large numbers under all swimming conditions and are constantly present in the swimming water. This suggests that staphylococci would also be an indicator of water pollution.

Amies (1956) discussed bacteria from the skin, hair, nose, and throat secretions which collect on the surface of swimming pool water. These secretions and bacteria tend to remain on the water's surface, protected from chlorine, and are more readily able to transmit bacterial and viral diseases. Dick, et al. (1960) basically substantiated Amies' findings and felt there was no reason for alarm. His studies indicated more bacteria on the surface than subsurface, but there was not a significant difference.

Disinfecting chemicals are used to control micro-organisms and organic material in swimming pools. Chlorine, which controls the microbial growth and has an oxidative effect on other materials in the water, is the most commonly used disinfectant.

Chemical

Hypochlorous acid (HOCl) is primarily responsible for the destruction of micro-organisms. When clorine is added to water, either as a gas or as a hypochlorite, both hypochlorous acid (HOCl) and hydrochloric acid (HCl) are formed: $Cl_2 + H_2O \longleftrightarrow HOCl + H^+ + Cl^-$. The reaction can proceed in both directions. When the pH of the water is less than 4, the reaction goes to the right and very little chlorine remains. The hypochlorous acid can dissociate depending on the pH. When the pH is between 6 and 8.5, the hypochlorous acid dissociates to hydrogen (H^+) and hypochlorite ion (OCl^-).

The following chart shows the relative quantities of HOCl and OCl^- at various pH levels (National Swimming Pool Institute, 1970).

pH	%Cl as OCl^-	%Cl as HOCl
6.0	3.5	96.5
6.5	10.0	90.0
7.0	27.5	72.5
7.5	50.0	50.0
8.0	78.5	21.5
8.5	90.0	10.0

The maintenance of the hydrogen ion (pH) and chlorine is important because the pH level has a direct relationship to the disinfectant abilities of the chlorine. Several other factors have to be considered as well: organic and inorganic materials, ammonia, and micro-organisms in the water. The organic and inorganic material and micro-organisms require chlorination and filtration for their removal. In the process, the chlorine levels drop depending on the quantity of material in the pool water. Sunlight and increased temperature also deplete the chlorine residuals.

There are specific legal requirements for maintenance of the hydrogen ion (pH) and residual chlorine content in a public swimming facility. The State of Oregon requires chlorine residual to be at a minimum of 0.4 and not to exceed 0.6 parts per million. The pH of the water must be maintained between 7.2 and 7.6 The American Public Health Association and the California Administrative Code require maintenance of pH at 7.2 to 8.4, and free residual chlorine at a minimum of 0.4 parts per million. They set no maximums for chlorine residual.

There are two types of chlorine residuals: combined available residual and free residual. A combined available residual is formed when chlorine is combined with nitrogenous compounds. This combination is called a chloramine. There are three main chloramine compounds that are formed, depending on the pH of the water and concentration of ammonia. When the pH is above 8.5, monochloramines are formed; when the pH is between 5.5 and 4.5, dichloramines are formed; and when the pH is lower than 4.5, trichloramines are formed. This type of chlorine residual is slow acting and not suitable for swimming pools.

The free residual chlorine is required by law for maintaining a swimming pool. Sufficient chlorine must be added to convert the nitrogenous compounds to chloramines. Then, with the addition of more chlorine, a free residual chlorine is increased in direct proportion to the amount of chlorine added to the water. This procedure is known as break point chlorination (Sconse, 1962; and Ehlers and Steel, 1965).

The pool water is not the only possible source for transmission of disease. The surrounding area (including walkways, shower rooms, and restrooms) provides an ideal means for transmission of disease agents. Iwanczuk (1965) reported on a study involving nine swimming pools in which the water samples were satisfactory, but parasitic worm eggs were found in surrounding areas. Three hundred eighty-six children were studied before and after a six-week swimming course. There was a seventeen percent increase in new cases of enterobius.

Absenteeism

Disease prevention in schools is an important aspect of national health care and was discussed by Randall (1971). Randall emphasized that the school must take an active role in prevention of all types of disease and promotion of school health through development of new attitudes of health and health practices. Prevention is the most economical aspect of medical services, and preventing illness and disease among students helps trim the mounting costs of curative or treatment procedures.

The interrelationship between illness and environmental factors is an important aspect of preventing disease. Balchum (1962) discussed this aspect and made the statement, "Respiratory disease is the result of environmental factors." Environmental factors affect man throughout his life, and have influenced the very nature of man.

Epidemiology studies have emphasized the aspect of environmental conditions by describing the causation of a disease. The classical or tripartite approach consists of three interesting factors: agent, host, and environment. The new approach is called the "web of causation." This approach expands on the tripartite theory and includes other factors in the cause of disease. Even when the specific agent is known, there are many contributing factors, or secondary causes, which influence the occurrence of a disease. This concept also recognizes that for some disease there may be no single agent, but a complex of two or more factors acting in concert.

Evans (1957 and 1962), in a ten-year study of illness patterns in University of Wisconsin students, found that respiratory infection was the leading cause of illness, followed by skin disorders, psychological problems, gastrointestinal disorders, and eye infections.

Approximately the same illness patterns can be identified in the high school and elementary school population. Rogers and Reese (1965) investigated the types of disease morbidity associated with absences and the effectiveness of present measures used to monitor and control these absences. This study indicated that most absences in the Dormont High School in Pittsburgh, Pennsylvania, were due to minor morbidity. Infectious respiratory diseases were the predominant cause of illness, with females having a slightly higher rate than males. Gastrointestinal illness was second, general systemic disease third, with the fourth and fifth causes being musculoskeletal and emotional.

Basco, et al. (1972), studied the problem of absenteeism in relation to nursing practices in the Delaware elementary schools. The main objective of the study was to delineate family characteristics that are associated with illness absence behavior. The second objective was to use the conclusions to develop new nursing practices. The results suggested that attitudes, family health factors, and stressful experiences all have an important effect on absentee patterns in the elementary schools. A substudy was conducted into the cause of absenteeism. Three-fourths of 381 pupils were absent because of illness, the major specific cause being respiratory infection.

Research on absenteeism appears to conclude that respiratory conditions are the leading cause of illness in the school population.

These findings are similar to those of the United States Bureau of Vital Statistics (1975), which state that respiratory conditions are the leading cause of illness in the general population and within the student-age groups.

The specific relationship of school performance and health was discussed by Starfield and Sharp (1971). Two issues were brought forth in this study. The first relates to the value of observations of health status and the second to the influence of medical care on improving school performance. In concluding that study, Starfield felt that teachers and physicians have complementary skills in diagnosing the health status of students. Teachers have total observation of students over a period of time and are able to identify changes that might occur with respect to individual differences. They can also compare a student with individuals of the same age. Physicians have the refined diagnostic techniques that can be applied at any time.

There appears to be a void in the literature on absenteeism with respect to the cause and effect of diseases within schools. The majority of the literature deals with the identification of emotional problem students through absentee records. However, there is evidence that the school environment can contribute to the transmission of disease. Gallagher (1948) studied the relationship of swimming and transmission of disease. He stated, "One of the chief functions of a student health service is to keep students well and at their classes;

the effect of any aspect of school life upon classroom attendance has to be considered and evaluated." (Gallagher, 1948: 902)

The school environment is made up of several smaller environments, each of which has its own unique problems and hazards. In order to provide the necessary preventative or control measures, each of these environments must be investigated.

Related Studies

There are two studies which have investigated the general health patterns in relation to swimming pool water quality. Gallagher (1948) studied disease patterns of a boys' school, comparing swimmers and nonswimmers. The second study was conducted by Stevenson in 1950. This study was not conducted in the school environment, but on fresh water swimming quality, and included one swimming pool.

Gallagher (1948), the school physician for the Phillips Academy for Boys in Massachusetts, conducted his investigation during the winter terms, from 1941 through 1974. The winter terms were eight weeks long, starting the second week in January. The boys who were enrolled for swimming were the only students allowed to use the pool during the terms studied. The rationale behind this regulation was to eliminate overcrowding and to control illness.

The pool was filtered, had a chlorination system and was maintained in accordance with the recommended practices of the American

Public Health Association. In addition, school policy was to close the pool when clorine levels became either too high or too low. The pool was also closed if serious illness developed among the swimmers.

The study included three classes of students: nonswimmers, occasional swimmers (those who swam less than seven times), and regular swimmers. The regular swimmers were not allowed to enter the pool if they had any symptoms of illness. Two groups of boys were excluded from swimming classes--those who had past histories of middle ear infections and those who had nasal sinus problems. These regulations were strictly enforced by the physical educators.

The data were presented and analyzed by use of percentages based on hospital admissions. Specific diseases were also reported: colds, influenza, pneumonia, pharyngitis, bronchitis, sinusitis, mumps, measles, chicken pox, scarlet fever, otitis media, and hemolytic streptococcus pharyngitis. There were several significant points in the discussion. First, there was a variation in rates of illness over the seven-year period. The rates ranged, among swimmers, from 0.14 to 0.77 admissions per boy. Gallagher interpreted this to mean that conclusions are unreliable unless they are based on data collected over a period of several consecutive years.

Further analysis of the data revealed that, during 1941, there were 0.77 hospital admissions per swimmer, as compared to 0.69 admissions for the nonswimmer. These results were the highest rates for the two groups during the seven-year period. The occasional swimmers also had their highest admission rate, 0.77, for the study period. In 1945, the lowest hospital admission rates were recorded, with 0.17 for swimmers and 0.191 for nonswimmers.

Second, Gallagher stated that swimming may be more hazardous to classroom attendance on the basis of higher incidence of respiratory illness and common contagious diseases such as measles and chicken pox. However, comparing the total days lost to the control group, the results were not very significant with only a two percent increase in illness in the swimming group.

Third, swimmers had a two percent higher incidence of respiratory illness than nonswimmers.

Fourth, the average number of admissions for the seven-year period was about fourteen percent greater for the regular swimmers. However, Gallagher felt that swimming instructors were more conscientious and sent their students to the hospital at the slightest indication of illness.

Fifth, the conclusions reached and stated in the summary are confusing and contradictory. Gallagher stated that there was an increase in illness of fourteen percent among swimmers because of repiratory infections, but then continued to say, "When careful control is exercised . . . there is . . . no reason to expect a higher incidence of respiratory infection among swimmers" (1948: 903).

Sixth, mumps and measles in this study spread more rapidly in the swimming group and extra precautions were needed.

Stevenson (September, 1953) commented on Gallagher's and other studies by stating, ". . . it should be reiterated that scientific proof of the direct relationship between bathing water quality and illness occurrence among bathers is not available. But certainly the preponderance of evidence is such to suggest that such a relationship does exist." (1953b: 8)

In the early 1950s Stevenson, in association with the Environmental Health Center, conducted field studies. These studies were to determine if a relationship existed between bathing water quality and illness. The specific objectives were to determine: (1) the frequency of swimming which might be expected from the population groups selected, (2) the relative increase in illness which might occur from swimming in even the cleanest waters, and (3) the differences in illness incidence due to swimming in waters of different bacterial quality.

Three geographical areas were studied: Lake Michigan, at two selected beaches in Chicago; the Ohio River at Dayton, Kentucky, and a nearby swimming pool in Dayton; and two municipal beach areas in Long Island Sound--New Rochelle and Mamaroneck, New York. There were six bathing areas in the study--five fresh water and one swimming pool.

A public information program was initiated surrounding each of the specific swimming areas. This program was directed to the families who used each of the areas and were asked to cooperate in the study. Calendars were furnished to record illnesses and swimming experiences. The record included familial diagnosis, including eye, ear, nose and throat ailments, gastrointestinal disturbances, and skin irritations. Follow-up studies were made to the households two or three times during the summer. Throughout the study, water samples were taken and tested for coliform organisms. Temperatures, rainfall, and wind were measured and recorded throughout the period. No control group was used.

The data were reported in 1, 000 person-days, with the under-ten-years-old age group doing twenty to forty percent of the swimming, and the under-twenty-years-old group doing sixty to seventy-five percent of the swimming. Consideration was not given to the beneficial aspects of outdoor swimming, such as fresh air, mental relaxation, moderate amounts of sunshine, and physical exercise.

The conclusions reached were "that higher illness incidence may be expected in the swimming group than in the nonswimming group, regardless of water quality." (Stevenson, 1953b: 16) Eye, ear, and respiratory ailments represented more than half of the overall illnesses, gastrointestinal disturbances approximately one-fifth, and skin irritations and other illnesses the remainder.

The illness rate increased progressively for higher individual swimming frequencies. However, the groups doing the most swimming tended to show less rise in illness, and in several instances, a marked decrease. This was explained by selective physical characteristics of individuals within the group.

A specific analysis was made of three selected days in the Great Lakes Region. Three days of high and low coliform content were chosen and compared to recorded illnesses. Those individuals who became ill within a week of swimming were within the illness period. The mean coliform density was 2, 300 per 100 ml, and the illness rate was 12.2 per 100 swimmers. The chi-square test was applied to the data at 0.01 level of significance. The results indicated that only one illness in 100 trials was due to chance. However, this evidence should not be taken as conclusive because of the sampling procedure. The weather was hot, and during this time, more people were swimming who might have had different illness characteristics than those who swam regularly.

Stevenson stated there was a significant difference in the illness rates of those persons using the Dayton swimming pool and those using the fresh water swimming areas. The illness rate per 1, 000 person-days was 13. 8 for the Dayton pool. The next highest illness rate, 13. 1, occurred at the Great Lakes Region.

The types of illness at the Dayton pool were eye, ear, nose, and throat infections, and these accounted for sixty-eight percent of all illnesses. Gastrointestinal disturbance was second, accounting for fifteen percent. Other illnesses were not tabulated separately, but combined into one category, which accounted for the remaining seventeen percent.

The reasons cited by Stevenson for the increased illness in the swimming pool were: first, the pool had diving facilities which could cause a greater penetration of bacteria into the respiratory tract; second, the closer proximity of bathers and the smaller amount of water available for dilution would aid in the transmission of infections.

In concluding, Stevenson stated, ". . . it appears from the observed results that some of the most rigid natural bathing water quality requirements could be relaxed without detrimental effect to the health of the bathers" (Stevenson, 1953b: 16).

Lackey (1953: 18) commented on the statement by Stevenson in regard to lowering the standards of coliform testing by stating, "Despite the statement that some relaxation of present strict bacterial quality requirements might be in order, the swimming pool situation requires further study." He continued by saying that this type of investigation and additional research is needed in this area and its relationship to illness.

The significance of the Stevenson study is reflected throughout literature as establishing a link between the transmission of disease and swimming pools.

Two studies have investigated the effect of aquatic activities on specific illness patterns of students. Humphrey and Ferinden (1948) studied the incidence of upper respiratory infections in three hundred male high school students. Their conclusions were rather remarkable, stating that there was no increase in upper respiratory infections, and that there was a possibility of higher resistance to colds developed through participation in aquatic activities.

Staton (1952) investigated the incidence of otorhinologic conditions in college men who participated in aquatic activities. There were one hundred ninety-four male college students ranging in age from seventeen to twenty-nine years. A medical history was taken and anyone having a predisposition to the common cold or upper respiratory tract infections was eliminated from the study. The results obtained indicated that there was not an increase in otorhinologic infections, and resistance to ear, nose, throat, or sinus infection was not markedly altered. Staton tested only for otorhinologic infections; the remaining results were surmised from direct observation.

Recent Trends

Education of pool operators is a comparatively new area being cited as a factor associated with illness. Fish (1969) and McCausland and Cox (1975), in their respective investigations, stated that improper pool operation was the cause of illness.

Fish (1969) reviewed the significance and control of microbiological hazards in swimming pools and concluded that there are a number of complex factors involved in control of micro-organisms in swimming pools. He stated, "Control requires vigilance and adequate supervision by competent pool operators who are knowledgeable about pool conditions and environment" (1969:281).

McCausland and Cox (1975) investigated an epidemic of skin disease in a motel swimming pool and whirlpool. The infection was attributed to an improperly operated whirlpool and the lack of daily monitoring of pool facilities. They also emphasized that, if there had been proper operation of pool equipment and maintenance of the pool, there probably would not have been a problem.

McCausland (1975) said that there is a need for certification of pool operators. This statement agrees with the "Reports of the National Environmental Health Association/National Swimming Pool Institute Workshop on Swimming Pool Sanitation and Safety" (1975) in emphasizing the need for adequate education of pool operators.

Summary

Different conclusions can be drawn from the research summarized in Chapter II as to the effect of aquatic activities on health. Several studies indicated a positive correlation between swimming and health. However, other studies have failed to show a significant increase in illness among swimmers. This has led researchers to state that there is a general impression that swimming is responsible for increased illness, and further study is needed (Amies, 1956; and Dick, et al., 1960).

Today, education of the sanitarian and pool operator is being examined as a possible variable in disease associated with swimming pools. Improper operation, as a result of inadequate knowledge, could possibly be a key factor. However, before further investigation of the relationship between education and disease transmission associated with swimming, there must be more adequate evidence as to the relationship between disease and the total swimming environment.

Respiratory conditions appear to be the main cause of illness in the school population, including the college student. Student health is an important factor within the schools. "The effect of any aspect of school life upon classroom attendance has to be considered and evaluated" (Gallagher, 1948:902). Swimming is an important part of many physical education programs, and if there is a possibility of illness associated with swimming, this could have an effect on the entire school.

There are few studies that confirm the fact that the swimming pool environment does not transmit disease. This study proposed to investigate the total aquatic environment and its relationship to illness. The research and methodology was designed to investigate the aquatic environment as a variable to determine if there was a significant difference in absenteeism between students who participated in indoor aquatic activities at Oregon State University and those who participated in other indoor physical education classes.

III. RESEARCH DESIGN AND METHODOLOGY

This chapter is designed to provide the data needed to test the six hypotheses, as well as to provide additional statistical information to aid in interpretation of the results. The first part deals with the unique conditions at Oregon State University, the population, the types of activities included in the study, and the methods for measurement of illness. The main sections describe the facilities and procedures used to collect and analyze the data.

There are difficulties in performing well-controlled epidemiological experiments on the human population. Subjecting humans to possible communicable diseases is not condoned and it should not be condoned. Therefore, certain limitations are placed on the types and procedures of such studies.

Fox (1970) and Friedman (1974) have discussed the naturally occurring experimental conditions. These conditions should be used whenever possible. Oregon State University provides these conditions in a unique opportunity to investigate the relationship between aquatic activities and health patterns.

There are two separate pools, each having a different design, i.e. type of construction, filtering system, mechanical operation, general maintenance operation. The swimming facilities are patronized by the general college population at specific times during the week. Complete chemical readings are kept and bathing loads are recorded daily.

Physical education is a requirement for graduation. Within the physical education department, students who are absent for reasons other than illness have an opportunity to make up the absence. Because of this procedure, the reporting of absences should be more accurate than in retrospective studies.

The population consisted of 763 male and female students enrolled in the physical education classes at Oregon State University, Corvallis, Oregon. The study took place during the Winter Quarter, January 3, 1975, to March 16, 1975, and the Spring Quarter, March 25, 1975, to June 8, 1975.

Indoor activities were chosen so that a protected environment could be maintained during the physical education classes. Three types of indoor activities were chosen. The first group comprised students who were enrolled in aquatic activities, the second group those involved with active sports, and the third group those enrolled in inactive or leisure-type activities. There are two main distinctions between active sports and inactive sports. The first is that inactive sports do not require special clothing and street clothing is worn. The second is that inactive sports do not necessitate showers after the activity.

The classes were chosen on the basis of class time schedules. The aquatic activity that was scheduled for a specific time was matched with an active sport or inactive sport at the same time and day. The students involved with active sports used the same dressing rooms and showers as those participating in the aquatic activity.

Because the physical education classes were chosen by the student, a psychological test was administered to all the students during the spring quarter to determine if there was a difference in how they perceived their own health status. The California Psychological Inventory (CPI) Sense of Wellbeing (Wb) scale was used to determine if a significant difference existed. The CPI has been used to study personality traits and was designed primarily for use with what has been defined as the "normal" subject. The Sense of Wellbeing (Wb) scale has been used to indicate health and verve with high scores, with low scores suggesting diminished vitality and inability to meet the demands of everyday life (Gough, 1960) (Appendix B).

The validity of the (Wb) scale has been established by Gough (1960) and substantiated by Megargee (1972) in an analysis of several studies. The Sense of Wellbeing scale consists of forty-four items or statements, thirty-nine of which are to be answered negatively and five affirmatively. The answers basically consist of denials of various physical and mental symptoms such as, "I am troubled by attacks of nausea and vomiting," and "Several times a week I feel as if something dreadful is about to happen" (Appendix B).

The scale was derived from the Minnesota Multiphasic Personality Inventory. It was then extensively cross-validated by Gough, and questions were substituted from the CPI pool of questions and incorporated into the scale.

The CPI has been used in several studies dealing with psychosomatic ailments and psychological aspects of athletes and athletics. Stewart (1962) studied individuals with psychosomatic ailments, comparing them to a symptom-free group. The symptom-free group had higher scores on the (Wb) scale. Merriman (1960) used the CPI to study the personality traits in relation to motor ability of ninth to twelfth grade students. He found a higher correlation between motor ability and a sense of wellbeing. The CPI has also been used to study the psychological difference between athletes, substitute players, and non-participants of ninth through twelfth grade and college level students (Schendel, 1965). There were several findings in this study relating to the (Wb) scale: (1) in the ninth grade study, the athletes had a higher mean score than the non-participants; (2) in the twelfth grade study, the substitute players had a higher mean score than the non-participants; and (3) in the college study, there was a higher mean score in the substitutes group than in the regular players.

Psychosomatic illness and students' attitudes could possibly be a factor in choosing one activity over another; therefore, testing for this difference could be important.

Absenteeism was used as an index to measure illness. Recent studies have suggested that absenteeism from work or school may be a reasonable index of health and used as a surrogate method of measurement. The reasoning behind the selection of absenteeism is the fact that the individual is not able to function in his daily activities (United States National Center for Health Statistics, 1971; Grogono and Woodgate, 1971; and Moore and Frank, 1973).

Two questionnaires were used in this study. The first (general questionnaire) was designed to obtain the name, age, sex, geographical location, and identification number of the student (Appendix C). The second questionnaire was designed to solicit information on absenteeism, types of illness, whether the student consulted a nurse or physician, and participation in other aquatic activities within seven days prior to illness. This questionnaire was based on research findings in Chapter II and was reviewed by Dr. Noel B. Rawls, Benton County Health Officer; Dr. James E. Garvey, Director of Student Health Services; and members of the doctoral committee. There was agreement that the questionnaire covered most types of illness that could be expected to be associated with swimming pools.

Facilities

The study took place in three buildings: The Women's Building, Langton Hall, and the Memorial Union bowling area. The Women's

Building and Langton Hall each have a swimming pool, maintained by the same individual.

Both pools have different methods of filtration and were constructed and remodeled at different times. Gas chlorine is used for disinfection, and the same type of chlorination system is used in both. The Women's pool uses a high rate sand filter, and the Langton Hall pool uses an open rapid sand filtration unit. Chlorine tests are made three times a day, pH tests twice a day. Water samples are also taken daily and tested for coliform bacteria (confirmed test) at the University's microbiology laboratory. The results of these tests are recorded and filed in the office of the Dean of the School of Health and Physical Education (Appendix F).

Procedure

Permission to conduct the study was obtained from Charlotte L. Lambert, Head of the Department of Physical Education, and each professor responsible for the class in which the study took place. A time and date for the initial visit was agreed upon by the investigator and the professor. Two visits were made to each class--the first during the first part of the quarter, and the last at the end of the quarter.

During the first visit, a verbal explanation of the study was made to the students and they were told that participation in the study was voluntary. Only two students refused to participate. Any questions were answered, and an information sheet describing the study was available upon request by the student (Appendix D). The students were asked to fill out the two questionnaires and during the Spring Quarter the CPI Sense of Wellbeing scale was administered. This was scored by hand. During the last visit, only the absentee questionnaire was administered.

At the end of the quarter, the students' enrollment records were checked against the general questionnaires to see if any students had dropped the course before the end of the study. If they had dropped, they were removed from the study population. Also, when accurate attendance roles were kept, a verification of absences was made.

The study was reviewed and approved by the Oregon State Committee for Protection of Human Subjects. This was done in accordance with the policy on protection of human subjects of the United States Department of Health, Education and Welfare (Appendix E).

Analysis of Data

The basic statistical models for the tests of the hypotheses were the one- and two-way analysis of variance designs, with fixed category levels. Minutes absent was the dependent variable. Analysis of variance was selected because: (1) the data scales were of the equidistant interval type, (2) the dependent variables were assumed to be normally distributed, and (3) the variances were assumed to be common (Courtney and Sedgwick, 1975). The Pearson (r) Product Moment Correlation Coefficient was also used to correlate the CPI test results.

All tests of experimental hypotheses where the probability is greater than 0.05 were reported as non-significant. When a significant F value resulted, least significant difference (L. S. D.) was calculated by hand to determine the location of significant difference between the means. The mathematical formula for the L. S. D. tests was $t_{\alpha/2} \sqrt{2s^2/n}$ for equal cell size and $t_{\alpha/2} \sqrt{(1/n + 1/n)s^2}$ for unequal cell size, where t = student t tabular value, $\alpha/2 = 0.05$, n = number of observations, and s^2 = mean square error.

Hypotheses I, II, and III were tested, using a two-way analysis of variance with equal cell size fixed categories. The sample was randomly selected. The design models are as follows:

Sampling Matrix

	GROUPS		
Sex	Swimming	Active Sports	Inactive Sports
Male	50	50	50
Female	50	50	50

Statistical Matrix

Source of Variation	df	SS	MS	F
Groups	2	A	A/2	MS groups/MS error
Sex	1	B	B/1	MS sex/MS error
Interaction	2	C	C/2	MS interaction/MS error
Error	294	D	D/294	
TOTAL	299	E		

The statistical hypotheses were as follows:

H_1: There is no significant group effect.

H_2: There is no significant sex difference effect.

H_3: There is no significant interaction effect between groups and sex.

Hypotheses IV and V were tested, using a two-way analysis of variance with unequal cell size fixed categories. The design matrices are as follows:

Sampling Matrix

	Pool	
Quarter	Langton Hall	Women's Building
Winter	64	72
Spring	92	94

Statistical Matrix

Source of Variation	df	SS	MS	F
Pool	1	A	A/1	MS pool/MS error
Quarter	1	B	B/1	MS quarter/MS error
Interaction	1	C	C/1	MS interaction/MS error
Error	318	D	D/318	
TOTAL	321	E		

The statistical hypotheses were as follows:

H_1: There is no significant pool effect.

H_2: There is no significant quarter effect.

H_3: There is no significant interaction effect between pool and quarter.

Hypotheses VI was tested, using a one-way analysis of variance fixed categories with unequal cell size. A Pearson (r) Product Moment Correlation was used to correlate test scores and absences for each group. Raw scores were converted to standard scores as listed in the test manual (Appendix B).

Sampling Matrix

		Groups	
Scores	Swimming	Active	Inactive
CPI	186	124	58

Statistical Design Matrix: One-Way Analysis of Variance

Source of Variation	df	SS	MS	F
Groups	2	A	A/2	MS groups/MS error
Error	365	B	B/365	
TOTAL	367	C		

The statistical hypotheses were as follows:

H_1: There is no significant group effect.

H_2: There is a significant group effect.

The data for analysis of the hypotheses were classified, coded, and punched onto computer cards. These tests were run using the CDC 3500 computer at Oregon State University. The L. S. D. tests and other data were calculated and tabulated by hand.

Summary

This chapter provides the methodology and format used to study the relationship of indoor aquatic activities and illness. The procedure is designed to answer the questions originally proposed in Chapter I and give insight into broader theoretical and philosophical questions. The following chapter includes the actual results of the investigation without discussion of the implications.

IV. RESULTS

The purpose of this study was to investigate the illness patterns in students participating in aquatic activities as compared to those participating in other physical activities. The study was conducted at Oregon State University during the winter and spring quarters of 1975. Oregon State University, at Corvallis, Oregon, is located in the Willamette Valley between the Coastal and Cascade Mountain Ranges. The enrollment during the 1974-75 school year was 15,915 (Oregon Department of Higher Education, October, 1974). This chapter discusses the demography of the sample, analysis of group study, absence data, tabulation of chemical and bacteriological results, and results of the hypotheses tested.

Demography of the Sample

The sample for this study was comprised of three groups of students who participated in the physical education courses during the winter and spring quarters of 1975. The first group of students was enrolled in aquatic activities; this was the experimental group. The second and third groups were comprised of students enrolled in the active sports and inactive sports; these were considered the control groups. The three groups of activities took place indoors in one of three buildings : the Women's Building, Langton Hall, and the

Memorial Union. The aquatic activities took place in two swimming pools located in separate buildings, Langton Hall and the Women's Building. The courses included advanced, intermediate, and beginning swimming, senior life saving, water safety instruction, snorkling, and water polo. The active sports included judo, gymnastics, ballet, basketball, physical conditioning, and weight lifting. These active sports were distributed between Langton Hall and the Women's Building. The inactive sports consisted of bowling, billiards, ballroom dancing, and folk dancing. Bowling and billiards took place in the Memorial Union, and the remaining activities took place in the Women's Building.

A total of 819 students enrolled in the three activities were contacted in their classes and asked to take part in the study. Two students declined to participate and fifty-four students were removed from the study because (1) they swam in pools other than those in Langton Hall and the Women's Building, (2) they did not complete the course, or (3) they filled out the questionnaires incorrectly. These fifty-six students who did not participate in the study represented 6.83 percent of the sample. The remaining 763 students completed the study and Table 1 provides a summary of the study population. Table 2 provides a summary of the sampling distribution by activity and sex. There were 322 students who participated in aquatic activities, 230 in active sports, and 211 involved in inactive sports.

The students in aquatic activities represented the experimental group, and those in active and inactive sports represented the control groups.

Table 1. Dropout and Participation Percentages of the Study Population

Description	Number	Percentage
Total Sample for Study	819	100
Declined to Participate	2	0.24
Swam in Other Pools	20	2.44
Did Not Complete Course	25	3.05
Incorrectly Filled Out Questionnaire	9	1.10
Total Students Participating	763	93.17

Table 2. Sampling Distribution by Sex and Activity

Sex	Activity			Total
	Aquatic	Active	Inactive	
Male	185	149	120	454
Female	137	81	91	309
Totals	322	230	211	763

The ages of the students ranged from seventeen to thirty-one, with the average mean age of 19.86 years. The average varied only slightly from group to group. The largest difference occurred between the female aquatic sports group and the male inactive sports group, during the winter quarter. The difference was 1.2 years. Table 3 shows the average age by sex, activity, and quarter. The residential status of the students was as follows: 75.6 percent (577) were residents of Oregon; California was second with 9.8 percent (75); and the remaining 14.6 percent (111) were from other states and foreign countries.

Table 3. Age Distribution of Sample by Sex, Activity, and Quarter (N = 763)

Sex/Activity	Quarter: Winter N	Winter Range	Winter Average Age	Spring N	Spring Range	Spring Average Age
Female/Aquatic	58	18-27	19.3	79	17-25	19.7
Male/Aquatic	78	18-31	20.3	107	18-28	19.7
Female/Active	45	18-25	20.1	36	18-27	19.4
Male/Active	61	17-30	20.4	88	18-30	20.1
Female/Inactive	69	18-24	20.0	22	18-25	19.4
Male/Inactive	84	17-27	20.5	36	18-25	19.5

Absence Data

Before the absence data was tabulated, a review of instructors' records was made to determine if the students had completed the course; and when attendance was taken on a daily basis, the records were checked against the questionnaires for accuracy. The students who did not complete the course were removed from the study. The results of the instructors' attendance records indicated a discrepancy in number of days absent as reported by fourteen out of 271 students. Since not all instructors maintained accurate attendance records, these fourteen were retained in the study. Removing them would have created a bias in the sampling.

A total of 207 students were ill during the study period, representing 27.13 percent of the sample. These students missed a total of 426 class periods. Aquatic sports had the largest number of absences. There were 102 students absent, with 202 classes missed. The second largest number of illnesses occurred in the active sports, seventy-two students being absent and 150 classes missed. The least number of absences occurred in the inactive sports, thirty-three students being ill and missing seventy-four class periods. Table 4 summarizes these results.

Table 4. Absence Due to Illness By Activity (N=763)

Activity	Number Absent	Percent	Class Periods Missed
Aquatic Sports	102	13.37	202
Active Sports	72	9.43	150
Inactive Sports	33	4.33	74
Totals	207	27.13	426

Table 5 summarizes the absences by sex and by activity. The females had the largest number of absences (107), missing 235 class periods. The highest number of female absences by activity was in aquatic sports, both in the winter and spring quarters. The males had a total of 100 absences, with 191 missed class periods. The highest number of male absences by activity was also in the aquatic sports, during the winter and spring quarters.

The majority of absences occurred during the winter quarter. There were 123 students absent, missing 274 class periods. During the spring quarter, there were eighty-four students absent with 152 class periods missed. Table 6 summarizes these results, and includes the percentages of individuals absent from each group during the winter and spring quarter. During the winter quarter, fifty percent of the females who participated in aquatic activities were absent. In the spring quarter, 44.4 percent of females in the active sports

Table 5. Absences Due to Illness by Sex and Activity (N=763)

Sex/Activity	Absences	Percent	Class Periods Missed
Female/Aquatic (N=137)	54	7.08	122
Female/Active (N=81)	34	4.46	67
Female/Inactive (N=91)	19	2.49	46
Subtotals	107	14.03	235
Male/Aquatic (N=185)	48	6.29	80
Male/Active (N=149)	38	4.98	83
Male/Inactive (N=120)	14	1.83	28
Subtotals	100	13.10	191
Totals (N=763)	207	27.13	426

Table 6. Absence Data by Sex, Individual Activity and By Quarter

Sex/Activity	Quarter: Winter				Quarter: Spring			
	N	Absence	Percent	Class Periods Missed	N	Absence	Percent	Class Periods Missed
Female/Aquatic	58	29	50.0	74	79	25	31.6	48
Female/Active	45	18	40.0	36	36	16	44.4	31
Female/Inactive	69	17	24.6	42	22	2	9.1	4
Subtotals	172	64		152	137	43		83
Male/Aquatic	78	28	35.9	46	107	20	18.7	34
Male/Active	61	20	32.8	51	88	18	20.5	32
Male/Inactive	84	11	13.1	25	36	3	8.3	3
Subtotals	223	59		122	231	41		69
TOTALS	395	123		274	368	84		152

groups were absent. The third highest percentage of absences occurred in the female active sports group, winter quarter, with forty percent absent. Males in the winter aquatic sports were fourth, with a 35.9 percent absence rate.

Tables 7, 8 and 9 summarize the reasons for absence. The three leading reasons for both quarters as reported by the students were (1) respiratory illness, (2) throat infections, and (3) other reasons. During the winter quarter, the fourth leading cause of absence for the sample was gastrointestinal problems; fifty was nasal problems, and sixth was ear infections. The fourth, fifth and sixth causes of absence changes in the spring quarter; nasal problems was fourth, skin problems was fifth, and gastrointestinal problems was sixth.

Pool Facilities

The pool facilities in the Women's Building and Langton Hall were used for this study. Both pools were maintained by the same individual and chlorine readings were taken three times a day: at 8:00 a.m., 12:00 noon, and 4:00 p.m. The pH readings were taken twice daily: at 8:00 a.m. and at 4:00 p.m. Bacteriological samples were taken daily, along with bathing loads, water temperature, and room temperature. Appendix F provides a daily log of the results for the study period.

The chlorine readings ranged from 0.2 to 0.4 parts per million

Table 7. Cause of Absence by Activity

Cause	Activity			Total
	Aquatic	Active	Inactive	
Eyes	5	0	2	7
Ears	9	4	0	13
Nose	30	11	2	43
Throat	85	34	7	126
Respiratory	106	71	28	205
Gastrointestinal	14	16	4	34
Skin	12	8	0	20
Other Infections	1	7	1	9
Other Causes	28	58	13	99

Table 8. Cause of Absence by Sex and Activity

	Activity/Sex								
	Aquatic		Active		Inactive		Totals		
Cause	F	M	F	M	F	M	F	M	Total
Eyes	5	0	0	0	0	2	5	2	7
Ears	3	6	2	2	0	0	5	8	13
Nose	23	7	3	8	0	2	26	17	43
Throat	54	31	12	22	2	5	68	58	126
Respiratory	55	51	24	47	2	26	81	124	205
Gastrointestinal	9	5	15	1	3	1	27	7	34
Skin	5	7	5	3	0	0	10	10	20
Other Infections	1	0	7	0	1	0	8	0	9
Other Causes	20	8	7	32	1	12	47	52	99

F = Female M = Male

Table 9. Cause of Absence by Sex, Activity and Quarter

Sex/Activity	Winter Quarter									Spring Quarter								
	Eyes	Ears	Nose	Throat	Respiratory	Gastro-intestinal	Skin	Other Infections	Other Causes	Eyes	Ears	Nose	Throat	Respiratory	Gastro-intestinal	Skin	Other Infections	Other Causes
Female/Aquatic	4	3	10	35	36	6	1	1	13	1	0	13	19	19	3	4	0	7
Male/Aquatic	0	5	3	21	28	4	0	0	6	0	1	4	11	23	1	7	0	2
Female/Active	0	2	1	8	15	6	0	5	17	0	0	2	4	9	9	5	2	9
Male/Active	0	2	4	16	29	1	0	0	23	0	0	4	6	18	0	3	0	0
Female/Inactive	0	0	0	1	0	3	0	1	0	0	0	0	1	2	0	0	0	1
Male/Inactive	2	0	2	5	24	1	0	0	11	0	0	0	1	2	0	0	0	1
Totals	6	12	20	86	132	21	1	7	70	1	1	23	42	73	13	19	2	29

and the pH ranged from 7.2 to 7.6. The bacteriological tests for the coliform confirmed test were all negative. The average daily use for the Women's Building pool was 105, and for the Langton Hall pool the average was eighty-eight. The pool water temperatures ranged from 80° to 86°F., with four days below 79°F. The room temperatures ranged from 71° to 78°F.

The Women's Building pool contained approximately 140,000 gallons of water and was filtered through a high pressure sand filter at a rate of 550 gallons per minute. The Langton Hall pool contained 275,000 gallons of water and was filtered through a rapid sand filter at a rate of 600 gallons per minute.

Both pools were constructed of tile and the surface skimming action was accomplished by the use of gutters. The water discharged into the gutters was not recirculated, but discharged into the sanitary sewer. When the pool was not in use, the water level was maintained below the gutter level. As the bathing load increased, the water level rose to the gutter level and skimming of the water surface took place.

Results of the Hypotheses Tested

This study analyzed six hypotheses concerned with (1) the effects of aquatic activities on health patterns, (2) the effects of gender with respect to absences, and (3) the effects of swimming in different pools on health patterns. Three groups were used in the study: (1) students enrolled in aquatic activities, (2) students enrolled in active sports, and (3) students enrolled in inactive sports.

Absenteeism was used as a health index and measured in minutes of absence. The California Psychological Inventory (CPI) Sense of Wellbeing (Wb) scale was used to determine health attitudes of each group. One- and two-way analysis of variance procedures were used to determine if there was a significant difference between the mean scores of absenteeism. The Pearson (r) Moment Correlation Coefficient was used to compare the CPI scores and absence rates.

> HYPOTHESIS I: There is no significant difference in the amount of absenteeism due to illness between students who participated in aquatic acitivites and those who participated in other sports.

A two-way analysis of variance was used to test this hypothesis, and a random sample of fifty students from each group was used. The results of this test indicate there is no significant difference in absenteeism between the three groups. Therefore, this hypothesis was retained. A summary of the two-way analysis of variance is given in Table 10.

> HYPOTHESIS II: There is no significant difference in the amount of absenteeism due to illness between male and female students.

As Table 10 indicates, there appears to be a significant difference in absenteeism between genders. This hypothesis was rejected, with the F value indicating a significant difference at the 0.05 level.

Table 10. Means and Analysis of Variance Summary for Sex and Activity Effects on Absenteeism (N=300)

Sex/Activity	N	Mean Absent Score
Male/Aquatic	50	27.00
Male/Active	50	26.00
Male/Inactive	50	11.00
Female/Aquatic	50	49.00
Female/Active	50	38.00
Female/Inactive	50	25.00

Source of Variation	df[1]	SS	MS	F	P
Sex	2	19200	9600	4.51	<0.05
Activity	1	21066.7	21066.7	2.47	N.S.[2]
Sex x Activity	2	1400	700	0.16	N.S.[2]
Error	294	41666.7	141.7		
Total	299	83333.4			

[1] Degrees of Freedom: The number of ways in which the data are free to vary; the number of observations minus the number of restrictions placed on the data. (Courtney and Sedgwick, 1975).

[2] Not significant.

The means for the females was 112 and for the males, sixty-four. The comparison between the means revealed that the females were absent more often than the males. The interaction effect was not significant, indicating that the sex effect and group effect did not affect each other.

> HYPOTHESIS III: There is no significant difference in the amount of absenteeism due to illness between male and female students who participated in aquatic activities.

There is an a-priori hypothesis to determine if there is a sex effect on absenteeism for those students engaged in aquatic activities. A multiple comparison analysis was made between the mean scores of male and female students in aquatic activities. The least significant difference test (L. S. D.) was used, and the results indicated there is a significant difference at the 0.05 level. The means for female absenteeism was forty-nine and the male means was twenty-seven. The difference between the means was 22, and the L. S. D. value was 4.666. This test indicated a sex effect in aquatic activities, and the females had a significant increase in absenteeism. This hypothesis was rejected.

> HYPOTHESIS IV: There is no significant difference in the amount of absenteeism due to illness between students who used the Women's Building pool and those who used the Langton Hall pool.

A two-way analysis of variance procedure was used to test this hypothesis at the 0.05 level of significance. The test indicated that there was a significant difference in absenteeism between the two pools. The Women's Building pool had a higher absenteeism rate than the Langton Hall pool. An interaction effect occurred at the 0.05 level of significance, and the effect was plotted and found to be ordinal (Appendix G). This hypothesis was rejected. Table 11 summarizes the results of this test.

> HYPOTHESIS V: There is no significant difference in the amount of absenteeism due to illness between students who enrolled in aquatic activities during the winter quarter and those enrolled in the spring quarter.

Table 11 gives the results of this two-way analysis of variance. There was a significant difference in absenteeism between the winter and spring quarters. The winter quarter showed the highest absenteeism rate significant at the 0.05 level of significance. Therefore, this hypothesis was rejected. Interaction effect occurred and is plotted in Appendix G.

> HYPOTHESIS VI: There is no significant difference in perception of physical health status among students who are enrolled in a variety of indoor physical education classes as measured by *The California Psychological Inventory Sense of Wellbeing* scale.

A one-way analysis of variance procedure was used to test this hypothesis. *The California Psychological Inventory* (*CPI*) *Sense of Wellbeing* (*Wb*) scale was used to determine if there was a psychological effect between the three groups. The raw scores were converted to standard scores using the method explained in the *CPI* test manual (Gough, 1960). There was no significant difference in mean

Table 11. Means and Analysis of Variance Summary for Pool and Quarter Effect on Absenteeism (N=322)

Quarter/Pool	N	Means Absent Score (Minutes)
Winter/Langton Hall	64	25.78
Winter/Women's Building	72	59.72
Spring/Langton Hall	92	22.28
Spring/Women's Building	94	22.87

Source of Variation	df	SS	MS	F	P
Pool	1	31908	31908	6.616	<0.05
Quarter	1	233369.8	23369.8	9.033	<0.05
P x Q	1	21800.6	21800.6	6.172	<0.05
Error	318	74253.8	233.5		
Total	321	151332.2			

scores at the 0.05 level, and the hypothesis was retained. Table 12 provides a summary of the results.

The CPI scores and the minutes of absence were correlated with the use of the Pearson (r) Moment Correlation Coefficient. The results indicated that the aquatic sports have a low negative correlation (-0.211). The active sports showed a negative correlation of -0.170, and a slight positive correlation was found for the inactive sports (0.056).

Summary

This chapter has presented the results of the investigation of three groups of students enrolled in various physical education programs, indoors, at Oregon State University. The population consisted of 763 students participating in aquatic activities, active sports, and inactive sports, with the aquatic activities group being the experimental group, and the latter two the control groups. The data was presented without discussion as to implications. The major findings of the investigation indicated that (1) there was a higher incidence of disease during the winter quarter, (2) respiratory illness was the major cause of illness in both the winter and spring quarters, (3) the chlorine levels of both pools--Langton Hall and the Women's Building--were maintained below the recommended standards, (4) there was no significant difference in illness between the three groups, (5)

Table 12. Means and Analysis of Variance Summer for Psychological Effect Upon Students Participating in Aquatic Activities, Active and Inactive Sports (N=368)

Activity	N	Mean Scores
Aquatic Sports	186	47.91935
Active Sports	124	48.15323
Inactive Sports	58	49.01724

Source of Variation	df	SS	MS	F	P
Scores	2	5.335	2.668	0.2929	N.S.
Error	365	3.323	9.101		
Total	367	3.329			

females had a higher illness rate than males, and (6) there was no significant difference between the three groups of students on how they perceived their health status. The following chapter will discuss the results of the study in relationship to other studies, as well as the broader implications.

V. DISCUSSION AND IMPLICATIONS

Discussion

An assumption has been made that participation in aquatic activities increases the probability of disease. Taylor (1923), Cohen (1923), Welty (1923), Taylor (1939), Mezz (1940), and Maxwell (1941) theorized that there was an increase in illness from swimming and that this was due to self infection and the chilling effect on the individual. However, Hasty (1927) theorized that swimmers contaminated the water and the water transmitted pathogenic organisms to other individuals. Most of these investigators were not involved with actual research, but were theorizing from observations made in their medical practices.

Based upon research evidence, Stevenson (1953) supported the theory that swimming increases illness. However, Humphrey and Ferinden (1948) and Staton (1952) concluded from their research that swimming did not increase illness.

The literature on swimming and disease has suggested two possibilities. The first is that there are certain pathogenic microorganisms which can withstand the pool environment when operated according to the present standards. Based upon this possibility, there has been considerable discussion in literature with respect to proper testing methods, construction, and filtration of swimming pools.

The second possibility is that when pools are operated properly, there is no danger of increased illness. In support of this possibility, Fish (1969) and Mood (1975) emphasized the need for vigilance, supervision, and more adequate knowledge to control disease in the aquatic environment.

The purpose of this study was to investigate the possible association of disease to the swimming environment and to gain insight into the variables that might be related to disease transmission. The results of this study indicated a strong possibility that when swimming pools are operated according to recommended standards, there is no reason to believe that a higher incidence of disease occurs.

Demography of the Sample

There were three groups of students used in this study: an experimental group consisting of students enrolled in aquatic activities, and two control groups. The first control group participated in active sports and the second control group participated in inactive sports. Each of the activities occurred indoors, which provided a protected environment. The days and times of each activity were similar and those students who participated in the acquatic sports and active sports shared the same locker rooms and showers.

A total of 763 students completed the study, and these were almost evenly divided between the winter and spring quarters. There were slightly more males than females in the study, and the average age varied only slightly. A question arose as to why a student might choose one activity over another and whether or not there was a psychological difference in how the students perceived their health status. This question was answered by Hypothesis VI; the findings showed no significant difference. From this observation, it is assumed that the students who participated in the study represented a homogenous group.

Absenteeism

There was a higher incidence of disease during the winter quarter when compared to the spring quarter. However, this is not surprising since the United States Bureau of Vital Statistics (1975) indicated there is more illness during the winter months in the general population.

The three leading causes of absenteeism were consistent in the winter and spring quarters as well as in the sex groups. The major cause was respiratory illness, followed by throat infections, and other causes. Aquatic activities experienced the highest rate of absenteeism, followed by active sports, and inactive sports. An assumption could be made at this point by direct observation that there is an increase in absenteeism in aquatic activities. However, the results of Hypothesis I indicated there was no significant difference in the amount of absenteeism due to illness between students who participated in aquatic activities and those who participated in other sports.

Facilities

The students who participated in aquatic activities and active sports were controlled by the location and the time when the classes met. The location for the inactive sports did not meet this criteria because the activities were held in a different building. However, the day and time were controlled.

The pool facilities in the Women's Building and Langton Hall differed with respect to size and filtration methods. The same type of chlorination was used and the same operator tested and maintained both pools. A review of the pool tests revealed that the pH was maintained at recommended levels; however, the chlorine levels were not continually maintained at the minimum level. The average daily chlorine content in both pools was 0.33 parts per million and the range was 0.2 to 0.4 parts per million. Oregon state law required that a minimum level of 0.4 parts per million of chlorine residual be maintained in the pool water at all times. The chlorine residuals in both pools varied from day to day, with no continual high or low readings. The coliform tests for both pools were continually negative, and the water temperatures and room temperatures were similar. The bathing loads were within legal limits.

Even though the pools in the Women's Building and Langton Hall did not meet the specific criteria of the law with regard to chlorine residual, the results of testing Hypothesis I indicate that there is a margin of safety at the 0.4 parts per million level of chlorine residual. There is indication that some public health laws are based on presumptions providing a safety margin for the public protection (Goldsmith, 1972). Dwell (1974) found that an epidemic of adenovirus type 7 in a swimming pool was eliminated when the chlorine level in the pool was maintained at 0.3 parts per million. Taking the forgoing facts into consideration, an assumption can be made that the two pools were operated in a safe and sanitary way.

Discussion of Hypotheses Tested

> HYPOTHESIS I: There is no significant difference in the amount of absenteeism due to illness between students who participated in aquatic activities and those who participated in other sports.

This hypothesis was retained. The results indicated that there is no significant difference in the amount of illness between the swimming group and other activities. A review of Table 4 shows a higher percentage of illness in the swimming group, however, statistically, this could be due to chance. There is also a possibility that if chlorine residual were maintained in the pools at 0.4 parts per million, a reduction in absenteeism would have occurred.

This finding supports the major findings of Humphrey and Ferinden (1948). They found that there was no increase in illness among high school swimmers. A second finding in their study was that there was increased resistance to respiratory illness. This study does not support that finding.

The results of this study also support the findings of Staton (1952). He found there was no increase in otorhinologic infections, and resistance to ear, nose, throat, or sinus infections was not markedly altered. These findings conflict with conclusions reached by Gallagher (1948) and Stevenson (1953). Gallagher, in his study of swimmers in a boys' school, found that there was an increase of fourteen percent in hospital admissions in the swimming group and a two percent higher incidence of respiratory illness. However, Gallagher did add caution and stated, "When careful control is exercised, there is . . . no reason to expect a higher incidence of respiratory infection among swimmers"(1948:903). The Stevenson study concentrated on fresh water swimming areas, which included one outdoor pool. The illness rates for the pool were the highest for the entire study. Sixty-eight percent of all illnesses were caused by eye, ear, nose, and throat infections. The second major category was gastrointestinal illness, which accounted for fifteen percent. The reasons cited for the increased illness in the pool were: (1) diving could cause a greater penetration of bacteria into the respiratory tract, and (2) closer proximity of bathers and less water for dilution could aid in transmission of infections. No control group was used, and results were based on percentages without use of statistical testing.

The results of testing Hypothesis I indicate with a high degree of probability that in a properly operated pool, there is no increase in illness. However, there is sufficient evidence that disease outbreaks do occur, and they can be traced to specific swimming pools (Foy, et al., 1968; Fish, 1969; and McCausland and Cox, 1975). An assumption can be made that these pools were not being operated properly and the causes could be a lack of vigilance, supervision, and/or knowledge as emphasized by Fish (1969) and Mood (1975). Another aspect is the importance of accurate record keeping of bathing loads and chlorine and pH readings as a vital factor in evaluating the sanitation of any pool.

> HYPOTHESIS II: There is no significant difference in the amount of absenteeism due to illness between male and female students.

> HYPOTHESIS III: There is no significant difference in amount of absenteeism due to illness between male and female students who participated in aquatic activities.

These hypotheses were rejected. Hypothesis II tested the male and female population, and Hypothesis III tested the male and female aquatic participants. The results indicate, at the 0.05 level of significance, there is a gender difference. The females have a significant increase in absenteeism over the males.

The results of these two hypotheses substantiate research by Stennett (1967), Evans (1957, 1962), and Rogers and Reese (1965). Their research indicates that within the school population, females have a higher absenteeism rate than males. This pattern continues throughout the population as reported by the United States Bureau of Vital Statistics (1975). An assumption can be made with a high degree of probability that females can be expected to have a higher absenteeism rate than males.

> HYPOTHESIS IV: There is no significant difference in the amount of absenteeism due to illness between students who use the women's pool and those who use the Langton Hall pool.

> HYPOTHESIS V: There is no significant difference in the amount of absenteeism due to illness between students who enrolled in aquatic activities during the winter quarter and those enrolled in the spring quarter.

These hypotheses were rejected. There is a significant difference between illness in the two pools and between quarters. Caution should be used when interpreting these hypotheses, because interaction did occur between pools and quarters. The plotting indicates that the interaction occurred in the Women's Building pool during the winter quarter (Appendix G).

There are several explanations as to why the absenteeism means for the students in the Women's Building pool more than doubled during the winter. First, the test did not control for sex, and more females used the Women's Building pool than the Langton

Hall pool. Second, there was a significant sex difference throughout the entire study. The female population in all activities had a higher absenteeism rate than males. Third, the highest absenteeism rate for any activity by sex occurred during the winter quarter. The means more than doubled. Fourth, women are more conscious of their health and at the earliest sign of disease take precautions, such as refraining from activity that could cause lowered resistance, or they are less likely to accept their own illness and continue, despite minor illness.

The means for the women in all three areas are higher than for the men. Even though hypotheses were not established, a least significant difference test could be applied. The results indicated that female absenteeism in each category is significantly higher than the males. The largest difference in mean scores for the females occurred during the winter aquatic activities. There were differences in mean scores of twenty-two in the aquatic activities, thirteen in the active sports, and fourteen in the inactive sports. The L. S. D. (least significant difference) value was 4. 666 indicating there is a significant difference in each category. However, this does not explain the relationship of significantly higher mean scores for the women in aquatic activities during the winter quarter. Further study is needed in this area.

HYPOTHESIS VI: There is no significant difference in perception of physical health status among students who are enrolled in a variety of indoor physical education classes as measured by The California Psychological Inventory Sense of Wellbeing Scale.

This hypothesis was retained. There is no significant difference on The California Psychological Inventory (CPI) Sense of Wellbeing (Wb) scale between the three groups. A correlation test was also made and the results indicated that there is very little correlation between test scores and the amount of absences due to illness. Therefore, an assumption can be made on the basis of this test that students did not make their choice of activity on the basis of how they perceived their health status.

An important question still remains as to why women have an increased absence rate over men. This is especially critical in the aquatic activities. This hypothesis did not test for sex difference, and further study should be made in this area to determine if there is a psychological difference between men and women and how they perceive their health status.

Implications

The findings of this study indicate that (1) there is no significant increase in illness associated with swimming activities in indoor pools maintained in a safe and sanitary manner, even when chlorine residuals were less than required by law; (2) females have a significantly higher rate of absenteeism than males; (3) respiratory illness is the leading cause of absenteeism; and (4) there is no significant difference between the three groups with respect to their perceived health status, as measured by The California Psychological Inventory Sense of Wellbeing scale.

There are a number of complex factors that have to be considered in a swimming pool environment to prevent the transmission of disease. The results of this study indicate that pools can be maintained in a safe and sanitary way, and swimming is not contraindicated as a healthful sport either within the school environment or as a recreational activity. When there is an increase of illness in swimmers, it would be logical to assume that the pool was not being operated properly, and that there are other external variables which are responsible (Foy, et al., 1968; Fish, 1969; McCausland and Cox, 1975; and Mood, 1975).

To protect the public, laws have been established that provide protection against hazardous conditions. The State of Oregon has laws on the operation and maintenance of swimming pools. The results of this study indicate that these laws are adequate and even have a safety margin. The law requires 0.4 parts per million residual chlorine; however, the two pools were operated between 0.2 and 0.4 parts per million. An assumption was made that the pools were maintained in a safe and sanitary manner.

Based upon the findings of this study and findings of other researchers, the need for remodeling of all old pools, different testing methods, or adding requirements seems to be questionable. These results also provide support for the Oregon state laws on swimming pool sanitation (1971) which, at the present time, appear adequate in preventing disease. However, emphasis must be placed upon the testing for free residual chlorine and not total combined chlorine. Before more stringent physical requirements are made for the swimming environment, consideration should be given to other factors.

Gershon Fishbein (1975:535) commented on health standards by stating, "Health standards based on presumptions usually give the public a greater margin of safety than otherwise. But is it fair to expect industry to spend the money necessary to comply with health standards based on little more than presumptions? Perhaps more relevant to the current dilemma, is it legal?"

If this margin of safety exists, then the critical question to ask is why are there still outbreaks of illness, such as that caused by *Pseudomonas aeruginosa*? McCausland and Cox (1975) and Clepper (1975) have eluded to improperly maintained pools as the cause. This study tends to substantiate their findings. However, the cause of improperly maintained pools is the pool operator. In order to decrease the possibility of outbreak of disease and increased illness, the pool operator must have a technical background and must possess sufficient insight into the complexities of the operation. A precedent has been set by the Los Angeles County Public Health Code (May, 1964), which requires registration and certification of swimming pool service companies, technicians, and apprentices. Clepper (1975) also emphasized the need for more education of the swimming pool operator.

The sanitarian has direct responsibility for enforcement of swimming pool laws. Goldsmith (1972) commented on the responsibility of the sanitarian. He emphasized that sanitarians have been principally concerned with achieving and maintaining legal standards through surveillance and code enforcement. He continued by stressing the importance of reliance on education as a method of controlling and correcting hazardous conditions. As with any governmental agency dealing with law enforcement, it is impossible to have an official continually on the premises to insure compliance. Therefore, a meaningful educational approach must be maintained to extend the prevention aspects of environmental control. The results of this study support the contention that the physical factors of swimming pools do not have to increase the probability of disease, and that when a disease outbreak occurs the possibility of human error could be the major cause.

The implication of this study and others have a direct relationship to education in four areas: (1) education of the sanitarian, (2) education of the pool operator, (3) educational programs in the field of environmental health in institutions of higher learning, and (4) educational programs in health departments. These implications apply not only to swimming pools, but to the entire field of environmental health.

The sanitarian must have not only the technical knowledge to understand the complexities and interactions of the environment, but also must be able to communicate and provide a meaningful educational program to insure compliance when he is not on the premises. The sanitarian must also understand that human behavior is an important aspect of environmental problems.

Institutions of higher learning must assume the responsibility of developing curriculums that provide a basis for understanding human behavior and methodologies that will achieve effective and enduring results without the need of legislation. Health departments should also emphasize the educational approach in correction of environmental problems rather than relying solely on code enforcement. Goldsmith (1972) has emphasized that environmental deficiencies are symptoms of behavioral problems, and that environmental problems should not be formulated in terms of physical environment alone, but also in terms of behavioral concepts.

Combining these two elements could achieve effective and enduring results. Sanitarians must look beyond physical deficiencies to the intangible aspects of human values and motivational forces interacting upon a person at a particular time and circumstance.

Recommendations

This study has brought forth several items that could be explored in future research:

1. A replication of this study, confining all activities to one building and covering a longer period of time;

2. A replication of this study maintaining pool chlorine residual at a minimum 0.4 parts per million to see if a reduction in absenteeism occurs in the aquatic sports.

3. A replication of this study in outdoor pools;

4. A replication of this study comparing indoor and outdoor pools;

5. Additional study in the area of attitudes on health, especially between males and females;

6. In-depth studies of the implications of educational and behavioral aspects as a cause of illness and other environmental deficiencies;

7. Health department studies of their enforcement policies and encouragement of educational and behavioral approaches to environmental deficiencies;

8. Study by institutions of higher learning of their curriculums in the environmental health areas, and inclusion of educational and behavioral aspects of controlling environmental deficiencies; and

9. Thoroughly investigating the human element, before changing laws and imposing more stringent physical requirements.

VI. SUMMARY

The major purpose of this study was to investigate the effects of aquatic activities on the health patterns of the college student. The study was conducted at Oregon State University during the winter and spring quarters, 1975.

Three groups totaling 763 male and female students were studied. The first group was comprised of students enrolled in the aquatic activities in the Women's Building pool and Langton Hall pool, and was considered the experimental group. The second group participated in active sports, which required a change of clothing and showers after the class period. The experimental group and the active sports group were matched so that the activity took place in the same building, on the same day, and during the same time. The last group was the inactive or leisure sports group. These activities took place in the Women's Building and the Memorial Union. Time and day were controlled, coinciding with an aquatic activity.

Historically, researchers have assumed a direct relationship between illness and the use of swimming pools. However, during the last six years other researchers have questioned this relationship and thought there might be other factors involved besides the actual physical environment. Therefore, this study posed the question, "Does the indoor swimming environment affect the health of students?"

There were other research questions offered which centered around sex effects, psychological effects, and effects of pools on health patterns.

There were six hypotheses tested, using one- and two-way analysis of variance procedures, and absenteeism was used as the dependent variable. The first three hypotheses dealth with the effects of group activities and sex effects upon absenteeism. The fourth and fifth hypotheses tested the difference in absenteeism between the Women's Building pool and the Langton Hall pool by winter and spring quarters. The sixth hypothesis tested the three groups to determine if there was an attitude difference on how they perceived their health status.

Each class was observed twice during the quarter. On the first visit, the students were asked to complete an informational questionnaire soliciting name and demographic data. A second questionnaire was also used if the student had been absent; if the student was absent because of illness, they were asked to complete this questionnaire. The answers on this questionnaire provided reasons for the absence and whether or not the student had engaged in swimming during the preceding two weeks other than in their assigned classes. During the last visit, only the absentee questionnaire was presented for completion. In the spring quarter, the first visit also entailed administration of The California Psychological

Inventory (CPI) Sense of Wellbeing (Wb) scale.

The major findings of this study were:

1. There was no significant increase in illness associated with swimming activities in indoor pools maintained in a safe and sanitary way, even when chlorine residuals were less than required by law.

2. Females had a significantly higher rate of absenteeism than males.

3. Respiratory illness was the leading cause of absenteeism.

4. There was no significant difference between the three groups with respect to their perceived health status, as measured by The California Psychological Inventory Sense of Wellbeing scale.

The implications of this study tend to support the theory that the swimming environment, if properly maintained, does not increase illness; and that if illness does occur, other factors are involved. One of these factors could be the pool operator and how well he understands the importance of a properly maintained pool environment. The findings also suggest the importance of educational and behavioral aspects in environmental control with respect to the sanitarian, environmental health curriculums, and health department enforcement methods.

Suggesting for further study include the effect of outdoor pools on health patterns, effects of sex on health attitudes, effects of education on environmental deficiencies, and investigation into the human element before laws are changed requiring higher standards of a physical nature.

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APPENDICES

APPENDIX A

Absence Questionnaire

Student Body Card # ____________________

Length of Absence (days) _______________

ABSENCE QUESTIONNAIRE

I. 1. Was your absence due to an illness? (check one)

_____ Yes _____ No

(If your answer to the foregoing question was yes, complete the following; if your answer was no, do not continue with the questionnaire.)

Place an "x" next to the number if your answer to the question is yes.

II. Was your absence due to an infection or condition listed below?

_____2. Eyes
_____3. Ears
_____4. Nose
_____5. Throat
_____6. Respiratory system (eg., colds, pneumonia, influenza)
_____7. Gastrointestinal upset
_____8. Skin
_____9. Other infection(s)
_____10. Other illness, including chronic illness (eg., bronchitis, asthma, broken bones, muscle strain)

III. If your absence was due to any of the above, did you:

_____11. Consult a physician or nurse?
_____12. Go to the Student Health Center?
_____13. Become hospitalized?

IV. During the last seven days prior to your absence, did you:

_____14. Swim in any other pool besides the University pool?
_____15. Swim at other times besides your class period?
_____16. Swim in any pool? (for non-swimming classes)

APPENDIX B

California Psychological Inventory
Sense of Wellbeing Scale

Test Questions and Profile Score Sheets

Student Body I. D. # ______________

Answer yes or no.

Yes No

___ ___ 1. Several times a week I feel as if something dreadful is about to happen.

___ ___ 2. I find it hard to keep my mind on a task or job.

___ ___ 3. Sometimes I cross the street just to avoid meeting someone.

___ ___ 4. Once a week or oftener I feel suddenly hot all over, without apparent cause.

___ ___ 5. I can remember "playing sick" to get out of something.

___ ___ 6. I usually expect to succeed in things I do.

___ ___ 7. I am so touchy on some subjects that I can't talk about them.

___ ___ 8. I usually feel that life is worthwhile.

___ ___ 9. I think most people would lie to get ahead.

___ ___ 10. I have very few quarrels with members of my family.

___ ___ 11. At times I have a strong urge to do something harmful or shocking.

___ ___ 12. I don't seem to care what happens to me.

___ ___ 13. I am afraid to be alone in the dark.

___ ___ 14. I have nightmares every few nights.

___ ___ 15. I have a great deal of stomach trouble.

___ ___ 16. I have been afraid of things or people that I knew could not hurt me.

___ ___ 17. Any man who is able and willing to work hard has a good chance of succeeding.

___ ___ 18. I hardly ever feel pain in the back of the neck.

___ ___ 19. When I was a child I didn't care to be a member of a crowd or gang.

___ ___ 20. When I am feeling very happy and active, someone who is blue or low will spoil it all.

___ ___ 21. Everything tastes the same.

Yes No

___ ___ 22. Much of the time my head seems to hurt all over.

___ ___ 23. My people treat me more like a child than a grown-up.

___ ___ 24. I am made nervous by certain animals.

___ ___ 25. Some of my family have habits that bother and annoy me very much.

___ ___ 26. No one seems to understand me.

___ ___ 27. I dream frequently about things that are best kept to myself.

___ ___ 28. I have reason for feeling jealous of one or more members of my family.

___ ___ 29. There are certain people whom I dislike so much that I am inwardly pleased when they are catching it for something they have done.

___ ___ 30. My mouth feels dry almost all the time.

___ ___ 31. When I am cornered I tell that portion of the truth which is not likely to hurt me.

___ ___ 32. Life usually hands me a pretty raw deal.

___ ___ 33. I have one or more bad habits which are so strong that it is no use fighting against them.

___ ___ 34. I am bothered by acid stomach several times a week.

___ ___ 35. I get all the sympathy I should.

___ ___ 36. I have felt embarrassed over the type of work that one or more members of my family have done.

___ ___ 37. I have often felt guilty because I have pretended to feel more sorry about something than I really was.

___ ___ 38. The things some of my family have done have frightened me.

___ ___ 39. My skin seems to be unusually sensitive to touch.

___ ___ 40. I am troubled by attacks of nausea and vomiting.

___ ___ 41. I would have been more successful if people had given me a fair chance.

___ ___ 42. Almost every day something happens to frighten me.

Yes No

___ ___ 43. My family has objected to the kind of work I do, or plan to do.

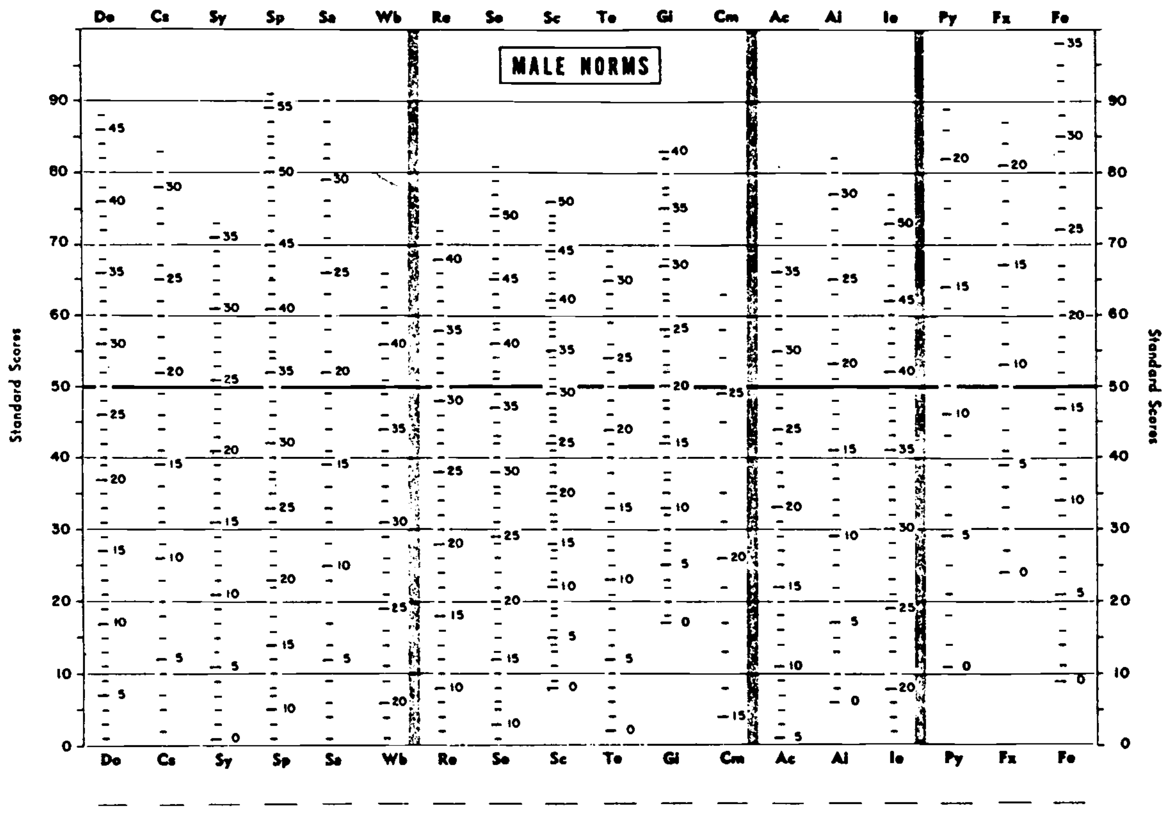
___ ___ 44. There seems to be a lump in my throat much of the time.

PROFILE SHEET FOR THE *California Psychological Inventory*: MALE

Name ____________________ Age ________ Date Tested ____________

Other Information ____________________

Notes:



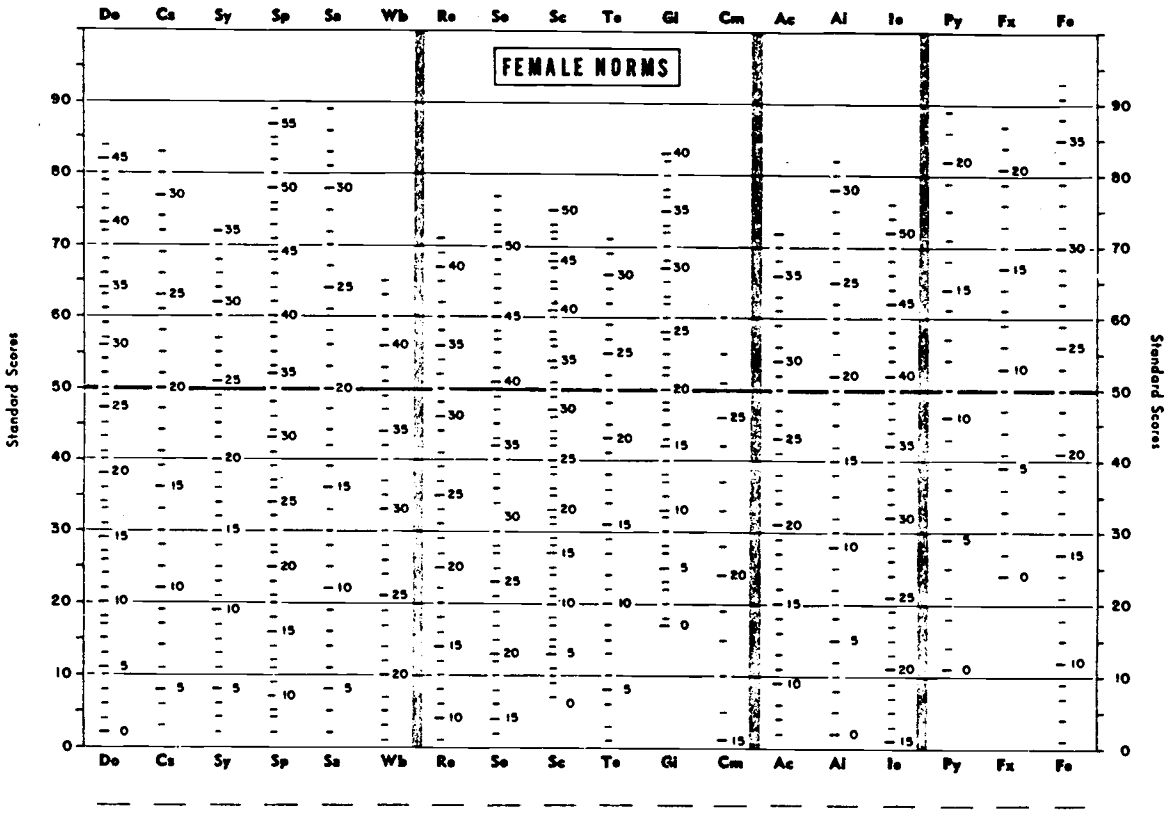
Male Norms

PROFILE SHEET FOR THE *California Psychological Inventory*: FEMALE

Name ______________________ Age ________ Date Tested ______________

Other Information ______________________

Notes:



Female Norms

APPENDIX C

General Questionnaire

QUESTIONNAIRE

1. Name ____

2. Age ____

3. Sex ____

4. City and State of residence before enrolling at OSU ____________

   ____

5. Identification Number (student body card number) ______________

   ____

6. Were you involved in this study during the winter quarter? _____

   ____

APPENDIX D

Information Sheet

A STUDY OF SWIMMING AND NON-SWIMMING STUDENTS
(Information Sheet)

1. Object of Study: To determine if there is an increase in absence due to illness in students who are enrolled in a swimming class as compared to non-swimming students.

2. Procedure for Study: Each student in the study will fill out a questionnaire, giving name, city where living before enrolling at OSU, sex, and age. Also an identification number (student body card number) will be asked for. This identification number will be used on the weekly questionnaires for those students absent from class. Names will not be released and information obtained from the questionnaire will be used only for statistical purposes. Each student will be asked to fill out a third questionnaire relating to health attitudes.

3. Discomforts and Risks: None. This is a "natural controlled" study under normal conditions. It is important to the study, in fact, to operate the pool and classes in a normal fashion.

4. Importance of Study: To determine if there is an influence of swimming on illness patterns of students.

5. Alternative Procedure: Would be to have no questionnaires, but there is no other feasible way to obtain the information. Safeguards for anonimity have been arranged. The first questionnaire and supplemental questionnaires will be kept in separate locations.

6. Participation and Non-participation: This is a voluntary study and students who wish not to participate or to withdraw from the study can do so at any time by informing the researcher.

7. All records will be kept confidential. Random sampling of participating students will further insure anonimity.

8. Inquiries: If there are any questions on procedures, please contact:

Ronald C. Schultz, Grad. Asst.
Dept. of Health
307 Waldo Hall
754-2686

APPENDIX E

Human Subjects Study Approval Sheet

OREGON STATE UNIVERSITY

Committee for Protection of Human Subjects

Summary of Review

Title: A Study of Swimming and Non-Swimming Students

Program Director: Arthur Koski (Ronald C. Schultz)

Recommendation:

XXX Approval

____ Provisional Approval

____ Disapproval

____ No Action

Remarks:

Date: 1/29/75

Signature: ____________________

J. Ralph Shay
Assistant Dean of Research
Phone: 754-3437

cc: Dr. MacDonald

OREGON STATE UNIVERSITY

A PROPOSAL FOR PROJECT INVOLVING HUMAN SUBJECTS

Principal Investigator Koski (Last Name) Arthur (First Name and Initial)

Department ______ Telephone Ext. 2686

Project Title A Study of Swimming and Non-Swimming Students

Present or Proposed Source of Funding none

Oregon State University has adopted the Policy on Protection of Human Subjects of the U. S. Department of Health, Education and Welfare. This requires that research and other activities involving human subjects be initially and continually reviewed by the OSU Commitee for the Protection of Human Subjects. This is in the interest of the investigators to protect them against possible legal action. For full instructions consult the following documents on file in the Office of the Vice President for Research and Graduate Studies: Memo issued by Vice President Roy A. Young to all principal investigators on February 6, 1973; the OSU document of compliance with DHEW policy; and "The Institutional Guide to DHEW Policy on Protection of Human Subjects."

Type of Project: ____ Faculty research project
____ Instructional (course) activity
____ Other; specify ______
x Graduate student thesis project*
(Student's name Ronald C. Schultz; date degree expected to be conferred 1976)

Initial

1. A description (proposal) of the planned research is included and contains information so that reviewers not familiar with the field can evaluate the human risks and overall benefits. All activities and procedures involving human subjects are detailed on pages 1 to 3 of this proposal. ____

2. The risks to the subjects are specified by their nature, intensity or seriousness, and probability of occurrence on pages 1 . ____

3. Expected benefits from the research to the subjects and to the advancement of knowledge, as well as supportive arguments that the benefits justify the risks are presented on page 1 . ____

4. The proposal includes the prior experience of all investigators listed in the proposal wherein human subjects have been used. Also it includes the laboratory animal data required, where relevant, for assessing the risks. n/a ____

5. Included in the proposal are: (1) a copy of any questionnaire to be completed by the human subjects to be involved and (2) a complete statement illustrating the method to be used for obtaining written informed consent of each subject, including a statement to be signed by the subject and a witness when the risk is judged significant (blood samples, etc.). ____

Initial

6. Two copies of this completed proposal are being forwarded to the Office of the Vice President for Research and Graduate Studies, who in turn will submit it to the Committee for the Protection of Human Subjects. ______

Signed ______________________________ Date 1/22/75
Principal Investigator/Project Director

* Proposal should be submitted by the major professor, and his name entered as Principal Investigator.

R-5-74

APPENDIX F

Swimming Pools' Daily Logs and Operation Records

SWIMMING POOL DAILY REPORT - OPERATION RECORD
MEN'S GYM - JANUARY 1975

Date	Number Persons Using Pool	Temperature Room	Temperature Water	Residual Chlorine mg/L Time of Day 8:00 a.m.	12:00 p.m.	4:00 p.m.	pH Value Time of Day 8:00 a.m.	4:00 p.m.
1	0							
2	0	72	81	0.4	0.3	0.3	7.6	7.6
3	0	72	81	0.3	0.2	0.4	7.6	7.6
4	0							
5	0							
6	10	72	81	0.4	0.4	0.4	7.6	7.6
7	0	72	81	0.3	0.2	0.4	7.6	7.6
8	20	72	81	0.3	0.4	0.3	7.6	7.6
9	28	72	81	0.3	0.4	0.3	7.6	7.6
10	23	72	81	0.2	0.3	0.4	7.6	7.6
11	0							
12	0							
13	73	72	81	0.3	0.3	0.2	7.4	7.6
14	119	72	81	0.2	0.4	0.3	7.4	7.6
15	46	72	81	0.3	0.4	0.2	7.4	7.6
16	73	72	81	0.2	0.3	0.3	7.6	7.6
17	19	72	81	0.3	0.4	0.3	7.4	7.6
18	0							
19	0							
20	85	78	81	0.3	0.4	0.3	7.6	7.6
21	74	78	81	0.3	0.4	0.3	7.6	7.6
22	91	78	81	0.3	0.3	0.3	7.4	7.6
23	113	78	81	0.3	0.4	0.3	7.6	7.6
24	20	78	81	0.3	0.3	0.3	7.6	7.6
25	44							
26	20							
27	163	78	81	0.3	0.3	0.4	7.4	7.6
28	111	78	81	0.3	0.3	0.4	7.6	7.6
29	85	78	81	0.3	0.3	0.3	7.6	7.6
30	79	78	81	0.2	0.2	0.2	7.4	7.6
31	15	78	81	0.4	0.3	0.3	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD

WOMEN'S BUILDING, JANUARY 1975

Date	Number Persons Using Pool	Temperature		Residual Chlorine mg/L Time of Day			pH Value Time of Day	
		Room	Water	8:00 a.m.	12:00 p.m.	4:00 p.m.	8:00 a.m.	4:00 p.m.
1								
2	0	76	86	0.3	0.3	0.4	7.6	7.6
3	0	72	81	0.4	0.4	0.4	7.6	7.6
4								
5								
6	0	76	82	0.4	0.4	0.4	7.6	7.6
7	0	76	83	0.3	0.4	0.4	7.6	7.6
8	0	76	86	0.3	0.4	0.3	7.6	7.6
9	0	76	86	0.4	0.4	0.4	7.6	7.6
10	0	76	86	0.4	0.4	0.3	7.6	7.6
11	62							
12	37							
13	113	76	86	0.4	0.3	0.4	7.6	7.6
14	145	76	86	0.2	0.3	0.3	7.6	7.6
15	171	76	86	0.4	0.3	0.3	7.4	7.6
16	157	76	86	0.2	0.3	0.3	7.6	7.6
17	107	76	86	0.3	0.4	0.3	7.6	7.6
18	62							
19	52							
20	153	76	86	0.4	0.4	0.4	7.4	7.6
21	160	76	86	0.4	0.3	0.3	7.6	7.6
22	175	76	86	0.3	0.4	0.3	7.6	7.6
23	172	76	86	0.2	0.3	0.3	7.6	7.6
24	145	76	86	0.3	0.3	0.3	7.6	7.6
25	34							
26	69							
27	152	76	86	0.3	0.3	0.4	7.4	7.6
28	186	76	86	0.2	0.4	0.3	7.6	7.6
29	105	76	86	0.4	0.3	0.4	7.6	7.6
30	156	76	86	0.4	0.3	0.2	7.4	7.6
31	99	76	86	0.4	0.3	0.3	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
MEN'S GYM, FEBRUARY, 1975

Date	Number Persons Using Pool	Temperature		Residual Chlorine mg/L, Time of Day			pH Value, Time of Day	
		Room	Water	8:00 a.m.	12:00 p.m.	4:00 p.m.	8:00 a.m.	4:00 p.m.
1	30							
2	16							
3	85							
4	109	78	81	0.3	0.4	0.2	7.6	7.4
5	71	78	81	0.4	0.2	0.3	7.4	7.6
6	107	78	81	0.2	0.3	0.2	7.6	7.6
7	17	78	81	0.3	0.4	0.2	7.4	7.6
8	0							
9	3							
10	42	78	81	0.3	0.3	0.3	7.6	7.6
11	108	78	81	0.4	0.3	0.2	7.4	7.6
12	43	78	81	0.3	0.4	0.2	7.6	7.6
13	104	78	81	0.2	0.3	0.3	7.6	7.6
14	61	78	81	0.2	0.3	0.3	7.4	7.6
15	0							
16	0							
17	39							
18	108	78	81	0.4	0.4	0.2	7.6	7.6
19	62	78	81	0.4	0.4	0.4	7.4	7.6
20	95	78	81	0.3	0.4	0.3	7.6	7.6
21	20	78	81	0.3	0.3	0.3	7.4	7.6
22	0							
23	0							
24	137	78	81	0.3	0.4	0.2	7.6	7.6
25	113	78	81	0.4	0.3	0.3	7.4	7.6
26	83	78	81	0.4	0.3	0.3	7.6	7.6
27	105	78	81	0.4	0.3	0.4	7.6	7.6
28	70	78	81	0.4	0.3	0.3	7.4	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
WOMEN'S BUILDING, FEBRUARY 1975

Date	Number Persons Using Pool	Temperature		Residual Chlorine mg/L Time of Day			pH Value Time of Day	
		Room	Water	8:00 a.m.	12:00 p.m.	4:00 p.m.	8:00 a.m.	4:00 p.m.
1	47							
2	89							
3	173							
4	192	76	86	0.3	0.4	0.4	7.6	7.4
5	170	76	86	0.3	0.3	0.4	7.4	7.6
6	118	76	86	0.2	0.3	0.3	7.6	7.6
7	111	76	86	0.3	0.4	0.2	7.4	7.6
8	63							
9	77							
10	103	76	86	0.4	0.3	0.3	7.4	7.6
11	211	76	86	0.4	0.4	0.3	7.6	7.6
12	193	76	86	0.3	0.3	0.2	7.6	7.6
13	212	76	86	0.2	0.3	0.4	7.6	7.6
14	96	76	86	0.4	0.3	0.4	7.4	7.6
15	78							
16	75							
17	171							
18	216	76	86	0.4	0.4	0.4	7.6	7.6
19	171	76	86	0.3	0.4	0.2	7.4	7.6
20	165	76	86	0.4	0.4	0.3	7.6	7.6
21	89	76	86	0.4	0.4	0.3	7.4	7.6
22	69							
23	53							
24	202	76	86	0.4	0.4	0.3	7.6	7.6
25	195	76	86	0.3	0.3	0.4	7.6	7.6
26	141	76	86	0.3	0.4	0.2	7.4	7.6
27	176	76	86	0.4	0.4	0.3	7.6	7.6
28	82	76	86	0.2	0.3	0.3	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
MEN'S GYM, MARCH, 1975

Date	Number Persons Using Pool	Temperature Room	Temperature Water	Residual Chlorine mg/L Time of Day 8:00 a.m.	12:00 p.m.	4:00 p.m.	pH Value Time of Day 8:00 a.m.	4:00 p.m.
1	0							
2	0							
3	92	78	81	0.3	0.3	0.3	7.6	7.6
4	110	78	81	0.4	0.3	0.4	7.4	7.6
5	87	78	81	0.3	0.4	0.3	7.6	7.6
6	77	78	81	0.4	0.4	0.3	7.6	7.6
7	31	78	81	0.4	0.2	0.3	7.6	7.6
8	0							
9	0							
10	91	78	81	0.3	0.4	0.3	7.4	7.4
11	115	78	81	0.3	0.3	0.3	7.4	7.4
12	86	78	81	0.4	0.3	0.3	7.6	7.6
13	94	78	81	0.4	0.3	0.2	7.6	7.6
14	18	78	81	0.3	0.3	0.3	7.6	7.6
15	0							
16	0							
17	0	78	81	0.3	0.4	0.4	7.4	7.6
18	21	78	81	0.3	0.4	0.4	7.6	7.6
19	25	78	81	0.3	0.4	0.3	7.6	7.6
20	24	78	81	0.2	0.4	0.2	7.6	7.6
21	0	78	81	0.2	0.3	0.4	7.6	7.6
22	0							
23	0							
24	23	78	81	0.4	0.4	0.4	7.6	7.6
25	27	78	81	0.4	0.3	0.3	7.6	7.6
26	20	78	81	0.4	0.4	0.2	7.4	7.6
27	26	78	81	0.4	0.4	0.2	7.6	7.6
28	21	78	81	0.4	0.3	0.3	7.6	7.6
29	0							
30	0							
31	0	78	81	0.3	0.4	0.4	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
WOMEN'S BUILDING, MARCH 1976

Date	Number Persons Using Pool	Temperature Room	Temperature Water	Residual Chlorine mg/L Time of Day 8:00 a.m.	12:00 p.m.	4:00 p.m.	pH Value Time of Day 8:00 a.m.	4:00 p.m.
1	65							
2	79							
3	153	76	86	0.4	0.4	0.3	7.6	7.6
4	177	76	86	0.4	0.2	0.4	7.6	7.6
5	146	76	86	0.4	0.3	0.2	7.4	7.6
6	151	76	86	0.4	0.3	0.4	7.6	7.6
7	95	76	86	0.4	0.3	0.3	7.6	7.6
8	57							
9	68							
10	143	76	86	0.4	0.4	0.4	7.4	7.2
11	149	76	86	0.4	0.4	0.4	7.2	7.2
12	83	76	86	0.4	0.3	0.2	7.6	7.6
13	137	76	86	0.4	0.4	0.2	7.6	7.6
14	100	76	86	0.3	0.3	0.3	7.6	7.6
15	62							
16	56							
17	0	76	86	0.4	0.4	0.4	7.4	7.6
18	0	76	86	0.3	0.4	0.2	7.6	7.6
19	0	76	86	0.3	0.4	0.4	7.6	7.6
20	0	76	86	0.3	0.4	0.4	7.6	7.6
21	0	76	86	0.2	0.3	0.4	7.6	7.6
22	0							
23	0							
24	0	76	86	0.4	0.3	0.3	7.6	7.6
25	0	76	86	0.4	0.4	0.4	7.6	7.6
26	0	76	86	0.2	0.4	0.4	7.6	7.6
27	0	78	86	0.3	0.4	0.4	7.6	7.6
28	0	78	86	0.4	0.4	0.3	7.4	7.6
29	0							
30	0							
31	0	78	86	0.3	0.4	0.4	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
MEN'S GYM, APRIL, 1975

Date	Number Persons Using Pool	Temperature Room	Temperature Water	Residual Chlorine mg/L Time of Day 8:00 a.m.	12:00 p.m.	4:00 p.m.	pH Value Time of Day 8:00 a.m.	4:00 p.m.
1	24	78	81	0.4	0.4	0.4	7.6	7.6
2	26	78	81	0.4	0.4	0.4	7.6	7.6
3	147	78	81	0.3	0.4	0.2	7.6	7.6
4	66	78	81	0.3	0.4	0.4	7.6	7.6
5	105							
6	80							
7	139	78	81	0.3	0.4	0.3	7.6	7.6
8	120	78	81	0.4	0.3	0.3	7.6	7.6
9	31	78	81	0.3	0.4	0.3	7.4	7.6
10	66	78	81	0.2	0.2	0.3	7.6	7.6
11	63	78	81	0.3	0.2	0.4	7.6	7.6
12	30							
13	0							
14	129	78	81	0.3	0.4	0.3	7.4	7.6
15	117	78	81	0.3	0.4	0.2	7.6	7.6
16	110	78	81	0.4	0.3	0.3	7.6	7.6
17	112	78	81	0.3	0.4	0.4	7.4	7.6
18	38	78	81	0.3	0.4	0.3	7.6	7.6
19	0							
20	0							
21	122	78	81	0.4	0.3	0.4	7.4	7.6
22	117	78	81	0.2	0.4	0.2	7.6	7.6
23	87	78	81	0.4	0.3	0.3	7.6	7.6
24	118	78	81	0.2	0.4	0.3	7.6	7.6
25	44	78	81	0.2	0.3	0.3	7.4	7.6
26	28							
27	0							
28	121	78	81	0.3	0.2	0.4	7.6	7.6
29	187	78	81	0.3	0.4	0.4	7.6	7.6
30	96	78	81	0.5	0.4	0.4	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
WOMEN'S BUILDING, APRIL, 1975

Date	Number Persons Using Pool	Temperature		Residual Chlorine mg/L Time of Day			pH Value Time of Day	
		Room	Water	8:00 a.m.	12:00 p.m.	4:00 p.m.	8:00 a.m.	4:00 p.m.
1	80	76	86	0.4	0.3	0.3	7.6	7.6
2	95	76	86	0.4	0.4	0.3	7.6	7.6
3	43	76	86	0.4	0.3	0.4	7.6	7.6
4	40	78	86	0.4	0.4	0.4	7.6	7.6
5	0							
6	43							
7	156	78	86	0.4	0.3	0.3	7.6	7.6
8	165	78	86	0.4	0.4	0.4	7.6	7.6
9	163	78	86	0.4	0.3	0.2	7.4	7.6
10	189	78	86	0.4	0.4	0.3	7.6	7.6
11	167	78	86	0.3	0.4	0.4	7.6	7.6
12	32							
13	78							
14	196	78	86	0.3	0.4	0.3	7.4	7.6
15	163	78	86	0.4	0.3	0.3	7.6	7.6
16	188	78	86	0.4	0.3	0.4	7.6	7.6
17	170	78	86	0.4	0.3	0.4	7.4	7.6
18	171	78	86	0.3	0.2	0.4	7.6	7.6
19	53							
20	28							
21	208	78	86	0.3	0.3	0.3	7.4	7.6
22	187	78	86	0.4	0.3	0.4	7.6	7.6
23	200	78	86	0.4	0.3	0.3	7.6	7.6
24	137	78	86	0.3	0.4	0.4	7.6	7.6
25	170	78	86	0.4	0.3	0.4	7.4	7.6
26	31							
27	35							
28	206	78	86	0.3	0.4	0.3	7.4	7.6
29	172	76	86	0.4	0.3	0.3	7.6	7.6
30	198	76	86	0.2	0.3	0.3	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
MEN'S GYM, MAY, 1975

Date	Number Persons Using Pool	Temperature Room	Temperature Water	Residual Chlorine mg/L Time of Day 8:00 a.m.	12:00 p.m.	4:00 p.m.	pH Value Time of Day 8:00 a.m.	4:00 p.m.
1	111	78	81	0.3	0.4	0.3	7.6	7.6
2	51	78	81	0.3	0.3	0.3	7.6	7.6
3	29							
4	0							
5	113	78	81	0.3	0.3	0.3	7.2	7.4
6	120	78	81	0.3	0.3	0.3	7.2	7.4
7	98	78	81	0.4	0.3	0.3	7.4	7.4
8	46	78	81	0.3	0.3	0.3	7.2	7.4
9	24	78	81	0.3	0.3	0.3	7.4	7.4
10	40							
11	0							
12	101	78	81	0.3	0.3	0.3	7.6	7.6
13	54	78	81	0.3	0.3	0.3	7.6	7.6
14	100	78	81	0.4	0.3	0.3	7.6	7.6
15	58	76	78	0.4	0.4	0.4	7.6	7.6
16	0							
17	0							
18	0							
19	14	76	72	0.4	0.4	0.3	7.4	7.6
20	83	76	74	0.3	0.4	0.4	7.6	7.6
21	117	76	78	0.4	0.4	0.4	7.4	7.6
22	118	76	80	0.4	0.3	0.4	7.6	7.6
23	33	76	81	0.3	0.4	0.3	7.6	7.6
24	18							
25	0							
26	0							
27	78	76	81	0.2	0.3	0.4	7.6	7.6
28	114	76	81	0.4	0.3	0.2	7.6	7.6
29	78	76	81	0.3	0.4	0.3	7.6	7.6
30	27	76	81	0.4	0.4	0.3	7.6	7.6
31	31							

SWIMMING POOL DAILY REPORT - OPERATION RECORD
WOMEN'S BUILDING, MAY, 1975

Date	Number Persons Using Pool	Temperature Room	Temperature Water	Residual Chlorine mg/L Time of Day 8:00 a.m.	12:00 p.m.	4:00 p.m.	pH Value Time of Day 8:00 a.m.	4:00 p.m.
1	168	76	86	0.3	0.3	0.3	7.6	7.4
2	145	76	86	0.3	0.3	0.3	7.6	7.6
3	25							
4	0							
5	186	76	86	0.4	0.4	0.4	7.2	7.6
6	187	76	86	0.4	0.3	0.4	7.4	7.4
7	191	76	86	0.3	0.3	0.3	7.4	7.6
8	172	76	86	0.4	0.3	0.3	7.6	7.4
9	175	76	86	0.3	0.3	0.3	7.4	7.6
10	36							
11	38							
12	189	76	86	0.3	0.3	0.4	7.6	7.6
13	202	76	86	0.3	0.3	0.3	7.6	7.6
14	196	76	86	0.4	0.3	0.3	7.4	7.6
15	180	76	86	0.4	0.3	0.4	7.6	7.6
16	187	76	86	0.2	0.3	0.4	7.6	7.6
17	57							
18	35							
19	186	76	86	0.3	0.3	0.4	7.6	7.6
20	146	76	86	0.4	0.3	0.3	7.6	7.6
21	208	76	86	0.4	0.3	0.3	7.4	7.6
22	179	76	86	0.3	0.3	0.4	7.6	7.6
23	148	76	86	0.4	0.3	0.3	7.4	7.6
24	10							
25	10							
26	0							
27	212	76	86	0.4	0.4	0.4	7.4	7.6
28	194	76	86	0.4	0.3	0.4	7.6	7.6
29	175	76	86	0.4	0.4	0.4	7.6	7.6
30	171	76	86	0.4	0.3	0.4	7.6	7.6
31	32							

SWIMMING POOL DAILY REPORT - OPERATION RECORD
MEN'S GYM, JUNE, 1975

Date	Number Persons Using Pool	Temperature		Residual Chlorine mg/L Time of Day			pH Value Time of Day	
		Room	Water	8:00 a.m.	12:00 p.m.	4:00 p.m.	8:00 a.m.	4:00 p.m.
1	0							
2	118	78	81	0.4	0.3	0.3	7.6	7.6
3	110	78	81	0.3	0.4	0.3	7.6	7.6
4	25	78	81	0.4	0.3	0.2	7.6	7.6
5	119	78	81	0.4	0.4	0.4	7.6	7.6
6	38	78	81	0.4	0.4	0.4	7.4	7.6
7	18							
8	0							
9	28	78	81	0.2	0.3	0.3	7.6	7.6
10	21	78	81	0.2	0.4	0.4	7.6	7.6
11	23	78	81	0.4	0.4	0.4	7.6	7.6
12	24	78	81	0.4	0.3	0.4	7.6	7.6
13	28	78	81	0.4	0.3	0.4	7.6	7.6
14	0							
15	0							
16	0	78	81	0.3	0.4	0.3	7.6	7.6
17	20	78	81	0.3	0.3	0.4	7.6	7.6
18	15	78	81	0.3	0.4	0.3	7.6	7.6
19	18	78	81	0.4	0.4	0.4	7.6	7.6
20	23	78	81	0.4	0.4	0.4	7.4	7.6
21	0							
22	0							
23	108	78	81	0.3	0.3	0.3	7.6	7.6
24	134	78	81	0.3	0.4	0.3	7.6	7.6
25	185	78	81	0.3	0.3	0.2	7.4	7.6
26	179	78	81	0.4	0.3	0.3	7.6	7.6
27	25	78	81	0.4	0.3	0.3	7.6	7.6
28	0							
29	0							
30	161	78	81	0.3	0.2	0.2	7.6	7.6

SWIMMING POOL DAILY REPORT - OPERATION RECORD
WOMEN'S BUILDING, JUNE, 1975

Date	Number Persons Using Pool	Temperature		Residual Chlorine mg/L Time of Day			pH Value Time of Day	
		Room	Water	8:00 a.m.	12:00 a.m.	4:00 p.m.	8:00 a.m.	4:00 p.m.
1	45							
2	46	76	86	0.3	0.4	0.4	7.6	7.6
3	41	76	86	0.4	0.4	0.3	7.4	7.6
4	50	76	86	0.4	0.3	0.4	7.6	7.6
5	44	76	86	0.4	0.4	0.4	7.6	7.6
6	51	76	86	0.4	0.3	0.2	7.4	7.6
7	19							
8	22							
9	0	76	86	0.4	0.4	0.3	7.6	7.6
10	0	76	86	0.2	0.3	0.4	7.4	7.6
11	0	76	86	0.4	0.3	0.3	7.6	7.6
12	0	76	86	0.3	0.3	0.4	7.6	7.6
13	0	76	86	0.4	0.4	0.4	7.6	7.6
14	0							
15	0							
16	49	76	86	0.3	0.4	0.4	7.6	7.6
17	125	76	86	0.4	0.3	0.4	7.6	7.6
18	123	76	86	0.4	0.3	0.2	7.6	7.6
19	109	76	86	0.4	0.4	0.4	7.4	7.6
20	102	76	86	0.4	0.4	0.3	7.6	7.6
21	0							
22	0							
23	22	76	86	0.4	0.3	0.3	7.6	7.6
24	228	76	86	0.4	0.4	0.4	7.6	7.4
25	199	76	86	0.4	0.3	0.2	7.2	7.6
26	190	76	86	0.4	0.4	0.4	7.6	7.6
27	48	76	86	0.4	0.4	0.2	7.6	7.6
28	35							
29	0							
30	276	76	86	0.4	0.4	0.4	7.6	7.6

APPENDIX G

Chart--Plotting of Interaction Between Pools and Quarters

PLOTTING OF INTERACTION
BETWEEN POOLS AND
QUARTERS

	Pool	
	Means	
Quarter	Langton Hall (L)	Women's Building (W)
Winter (X)	25.78	59.72
Spring (O)	22.28	22.87