

Occupational injuries, daily workload, and fitness levels among fitness and swimming instructors.

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Research

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Abstract

Introduction: Few data has been published on occupational disorders among sport instructors, especially regarding those who are expected to continuously practice while teaching. As the number of sport instructors is increasing, new specific information about their possible injuries, daily workload, and fitness levels is needed.

Objectives: The aim of this study was to assess occupational disorders, cardiorespiratory fitness, and daily workload of fitness (FI) and swimming instructors (SI).

Methods: An online survey addressing occupational disorders was conduct among 435 instructors (256 FI and 179 SI). In a subgroup, cardiorespiratory fitness level was evaluated using maximal oxygen consumption (VO_{2max}) as an indicator. Daily workload was monitored by heart rate (HR) and perception of exertion.

Results. Of the two groups, FI exhibited a higher 2-year prevalence of musculoskeletal injuries and SI experienced more upper respiratory tract infections. O_{2max} ranged from 47.0 ± 4.0 to 51.9 ± 3.7 $ml \cdot kg^{-1} \cdot min^{-1}$, and was similar between FI and SI. Regarding the daily workload, female SI had significantly higher HR_{mean} and HR_{mean}/HR_{max} compared to female FI, but no significant differences between male FI and SI were found. No significant differences were observed between the perceived exertion of FI and SI.

Conclusions. Preventive strategies for the reduction of occupational disorders in FI and SI are needed.

Background

The fitness industry is booming with the last 10 years showing a rapid increase in fitness club members and employees with almost 750.000 fitness employees in Europe alone [1]. In particular, the fitness industry is considered to include both fitness and/or swimming pool centers. In fitness centers customers can find lots of equipment for cardio and weight training or group fitness classes. In swimming pool centers customers can find different types of swimming classes as well as water aerobics courses. Fitness (FI) and swimming instructors (SI) are two different type of trainers usually employed in these centers. FI generally lead, instruct and motivate individuals or groups in exercise activities, including cardiovascular exercises, strength training and stretching. Typically, FI works with individual clients designing, explaining and demonstrating various exercises and routines, or teaches group classes where to organize and lead fitness lessons lasting 30-90 minutes. In these classes, instructors may set the music and choreography in exercise sequences, using also specific exercise equipment (e.g. stationary bicycles, weights, etc.). SI generally help people learn to swim, improve their swimming skills and to exercise in water. Moreover, they are also specialized to teach during water aerobics classes, in which they perform aerobic exercises with water immersed participants. These classes focus on aerobic endurance, creating an enjoyable atmosphere with music.

According to this, FI and SI profession is highly physically demanding. In fact, in most cases instructors have to practice while teaching and they may work nights, weekend, or holydays or have to travel to different gyms or to clients' home to teach classes or to conduct personal training sessions. However, despite the numerous health related advantages of physical activity and exercise, the risk of occupational disorders among FI and SI is poorly addressed. One of the first studies about this topic found that aerobic dance instructors during 29.924 hours of practice have 84 time loss injuries for a rate of 0.26 [2]. Moreover, Rothenberger et al. [3] found in a sample of 726 aerobic dancers that 49% of the subjects reported a history of at least one injury related to aerobic dancing. Most of the injuries were to the calf (24.5%), lower back (12.9%), and ankle (12.2%). Among the subjects injured, 23% reportedly saw a physician because of their injury. The frequency with which subjects exercised was associated with the history of injury. Subjects who exercised fewer than four times per week reported fewer injuries (43%) than those who exercised four times per week (60%) or more (66%). Another study, found a prevalence of occupational disorders among aerobics instructors as high as 77%, with the most frequent injury location being leg, foot/ankle and knee [4]. Romaine et al. [5] found that 31% of cardio-kickboxing instructors experienced injuries relates to such classes and reported back, knee, hip and shoulder as the most frequent injury locations. Malliou et al. [6] reported that 73.5% of step aerobics instructors had chronic lower extremity injuries. Solfrid Bratland-Sanda [7] reported a high prevalence of instruction-related injuries and musculoskeletal pain among fitness instructors.

In addition, FI and SI rely on their voices in a similar way that vocal performers, classroom teachers, salespeople, and others in vocally demanding professions do [8]. In fact, FI and SI reported voice difficulties that appear to be the result of an interaction between both environmental and physiological stress placed on the voice, as speaking and vigorous exercise occur simultaneously [9]. Indeed, FI and SI voice is an essential professional asset used not only to provide education and direction, but also to motivate and encourage class participants to persevere [10]. The vocal effectiveness of the instructor has a direct influence on the satisfaction of clients and keeps them motivated to return, and the amount and type of verbal motivation required is often driven by fitness genre [8]. There are also several factors that can strain the use of vocals because instructors vocalize with music and other noise sources and teach in acoustically poor spaces [10]. To this regard, Heidel & Torgerson [8] found that aerobics instructors generally experienced more hoarseness and episodes of voice loss during and after instructing and a significantly higher prevalence of laryngeal nodules. In the same way, Long et al. [10], observed that aerobics instructors experienced partial or complete voice loss during and after instructing, as well as increased episodes of voice loss, hoarseness, and sore throat unrelated to illness since they began instructing. Finally, Rumbach [9] identified that group fitness instructors are susceptible to a number of voice disorders (e.g. laryngeal pathology, vocal strain, dysphonia etc.) that impact their social and professional lives.

Since studies on the occupational disorders experienced by FI are limited and there is no information about SI, the primary outcome of this study was to investigate the 2-year prevalence of occupational disorders experienced by FI and SI employed in various fitness center companies through a self-reported questionnaire. In addition, the secondary outcome was to assess fitness levels, workloads and perceived

exertion during a typical working day of SI and FI, in order to explore the possible factors associated with occupational disorders in these work activities.

Methods

Study design

In order to assess the 2-year prevalence of occupational disorders experienced by FI and SI, a retrospective cross-sectional self-reported observational study was conducted. Subsequently, to investigate physical fitness and daily workload during a typical working day in FI and SI, a prospective cross-sectional observational sub-study was performed.

Participant screening

Participants were recruited from various fitness centers. These centers employed both FI (e.g. dance aerobics, step aerobics, spinning, pilates, yoga, low back pain exercise classes, strength training, boxing/kickboxing) and SI (e.g. water aerobics, swimming courses, mother/baby swimming courses). The inclusion criteria were being a FI or SI instructor and teaching a minimum of one class a week. The exclusion criterion was being unable to fill out the questionnaire. Potential participants e-mail addresses were provided by the head of each center. The responders were contacted by an email, in which they were fully informed about study procedures, benefits and risks associated with participation. Written informed consent was e-mailed and participant have to send it back signed. At this point, the online survey was e-mailed to the participant who agreed to participate and met above inclusion and exclusion criteria. Participant who agreed also to participate to the second part of the study were phone called in order to organize laboratory testing and daily workload monitoring.

The online survey

The on line survey was created according to the guidelines provided by Artino et al. [11]. Subjects were requested to complete an online survey during a 2 weeks period. The survey requested information regarding personal physical data, frequency, duration and time (early morning, morning, afternoon, or evening) of class participation. For the purposes of this study, all self-reported occupational disorders related to their work during the last two years were asked by answering the following question: "Have you experienced any occupational disorder as FI or SI during the last two years?" [7]. In case of positive response, participants had to specify each injury, type of injury (acute/overuse), in accordance with the definitions provided by a consensus statement regarding disorder registration [12]. A disorder was defined as any condition causing pain, limiting activity, or both. Only those participants who saw a physician for their disorders were asked to report a diagnosis. Participants who did not see a physician were asked only to report the location of the disorder. The extent of the disorder was examined through contingency questions regarding the limitation that the injury placed on activity. The survey took 20-25 minutes to complete.

Physical Fitness Assessment

Participants' physical fitness was assessed by maximal oxygen consumption assessment (O_{2max}). Oxygen consumption (O_2), carbon dioxide production (CO_2), and pulmonary ventilation (E) were measured using a metabolic device on a breath-by-breath basis (Quarkb² Cosmed, Rome, Italy) during a graded ramp cycle ergometer test (Monark Ergomedic mod. 839E, Monark, Vansbro, Sweden). All tests were carried out in a well-ventilated laboratory at a temperature of 20-22°C under standardized constant ambient conditions (i.e. a temperature of $22\pm 2^\circ C$ and humidity of $<70\%$). The protocol consisted of 3 minutes at 50W/min (warm up and familiarization), followed by an increase of 20W every minute until exhaustion. Achievement of O_{2max} was considered as the attainment of at least two of the following criteria: 1) a plateau in O_2 levels despite increasing speed; 2) a respiratory exchange ratio above 1.1; and 3) a HR of ± 10 bpm of age-predicted maximal HR (i.e. $220 - \text{age}$) [14]. Heart Rate (HR) was recorded during the entire test using a HR monitor (Polar RS800, Polar Electro 2011, Kempele, Finland). Maximal HR at exhaustion was considered as HR_{max} .

Daily Workload Monitoring

Each participant was equipped with a HR monitor (Polar RS800, Polar Electro 2011, Kempele, Finland) and instructed to wear it during their typical workday for one week. HR recordings were expressed in the percentage of the maximum value ($\%HR_{max}$) reached during the maximal oxygen consumption assessment. All the HRs obtained were then compared to the American College of Sports Medicine recommendations [16] for the development of aerobic fitness, which define the relationship between work HR ranges and work intensity. Participants were asked to continue their normal daily working routine and to maintain their usual diets during the monitoring period.

Rating of Perceived Exertion Assessment

The Borg CR100 scale [14] was selected to rate the perceived exertion of a typical lesson. A verbal-anchored was provided to the participants who were instructed to use it 30-min after the end of their working day. Each participant was familiarized with the Borg CR100 scale, including anchoring procedures.

Statistical Analysis

Respondents with missing data were excluded from the analysis. Descriptive statistics (mean \pm standard deviation, $m \pm SD$) for the outcome measures were calculated. The normality of the distribution was checked using graphical measures and the Kolmogorov-Smirnov test. Since all anthropometric variables were normally distributed, differences between male and female FI and SI were checked using an unpaired Student's t-test. A Chi-square test was used to compare the questionnaire's variables of educational level, professional information, and job characteristics between FI and SI groups. Differences between FI and SI were studied using the Student's paired t-test when analyzing the perceived exertion after the maximally fatiguing workday and the perceived exertion 30 minutes after the end of their

lessons. Intra- and intergroup differences (gender ´ instructor type) between in daily workload for FI and SI for O_{2max} , HR_{mean} , and HR_{max} were checked using two-way analysis of variance with Bonferroni's multiple comparisons test. The level of statistical significance was set at $p<0.05$. Statistical analysis was performed using the software STATISTICA (version 7.1, StatSoft, Tulsa, OK, USA).

Results

Participants Screening Results

Study population included 472 participants with 435 instructors that completed the online survey, with a response rate of 92.2%. Ninety-seven subjects (57 FI and 42 SI) agreed to also participate in the secondary phase of the study and were tested in order to evaluate fitness level, workload monitoring and perceived exertion of a typical working day (Figure 1).

Online Survey Results

Table 1 shows participants' demographic characteristics. The subjects in each group were similar in age, height, body mass and body mass index (BMI). Moreover, the number of years spent in their profession was >10 years in only a small percentage of both work groups and the number of weekly work hours was <10 hours in more than half of all FI and between 10 and 30 weekly hours in SI.

Table 1. Questionnaire results regarding demographics and job characteristics.

	FI	SI
Demographic and general characteristics		
Males (n, %)		
Age (years)	152, 59	75, 41
Height (m)	28±6	30±8
Body mass (kg)	1.72±0.06	1.72±0.08
BMI (kg×m ⁻²)	66±8	66±8
	21±3	22±3
Job type		
FI/SI as main occupation (%)	41	46
FI/SI as secondary occupation (%)	59	54
Career duration (years)		
>5 years (%)	52	41*
5-10 years (%)	33	31
>10 years (%)	15	28**
Weekly working hours		
<10 h (%)	51	31**
10-30 h (%)	37	54**
>30 h (%)	12	15

Legend. Data are expressed as percentages of FI and SI groups. FI, fitness instructors; SI, swimming instructors.

Overall, a total of 621 musculoskeletal disorders and 521 of other disorders were reported in the study with 157 and 155 participants that experienced 2 or more injuries during the last two years. Figure 2 illustrates the 2-year prevalence of occupational disorders that occurred in the FI and SI career, divided into musculoskeletal and other disorders. The percentages of ankle, knee, and wrist sprains, shoulder dislocations, contusions, muscle pulls and contractures, lower back pain, and articular pain were significantly higher in the FI group ($p=0.032$) versus the SI group. Non-musculoskeletal diseases such as bronchitis, sore throat/aphonia, and headache were significantly more common in the FI group ($p=0.014$) whereas warts and upper respiratory tract infections were more frequent in the SI group ($p=0.025$).

Physical Fitness Results

FI and SI groups did not differ significantly in O_{2max} .

Daily Workload Monitoring Results

The FI and SI O_{2max} , HR at rest, and HR_{max} classified by gender and instructor type are shown in Table 2. FI and SI groups did not differ significantly in O_{2max} , HR at rest, and HR_{max} , and no interaction between gender and instructor type was observed between groups. Additionally, the HR_{mean} during 3 hours of a typical workday and the ratio between HR_{mean} and HR_{max} was shown in Table 2. While there was no significant main effect between male SI and FI, the female SI displayed significantly higher HR_{mean} and HR_{mean}/HR_{max} ($p=0.018$, $p=0.022$, respectively) than female FI.

Table 2. Physiological variables during maximal oxygen consumption assessment and heart rate data during daily workload monitoring of FI and SI.

Parameter	Males		Females	
	FI (n = 25)	SI (n = 9)	FI (n = 32)	SI (n = 33)
Exercise test				
HR_{rest} (beats·min ⁻¹)	66 ± 14	62 ± 14	66 ± 13	65 ± 10
HR_{max} (beats·min ⁻¹)	186 ± 5	186 ± 4	187 ± 4	187 ± 5
O_{2max} (mL·kg ⁻¹ ·min ⁻¹)	51.9 ± 3.7	50.9 ± 3.8	48.9 ± 3.6	47.0 ± 4.0
Daily HR recording				
HR_{mean} (beats·min ⁻¹)	127 ± 28	144 ± 6	126 ± 21	139 ± 19*
HR_{mean}/HR_{max}	0.69 ± 0.14	0.78 ± 0.40	0.68 ± 0.11	0.75 ± 0.10*

Legend. Data are expressed as mean±SD. O_{2max} , maximal oxygen consumption; HR, heart rate. HR_{mean} , average HR during a typical workday; HR_{mean}/HR_{max} , ratio between work HR and maximal HR. * $p<0.05$ FI vs SI group.

Rating of Perceived Exertion Results

The perceived level of exertion after a typical workday was 72.3 ± 16.2 AU (i.e., arbitrary units in the CR100 scale, a point-scale up to 100 with 100 being the maximum possible level of exertion.) [14] in FI and 72.0 ± 18.0 AU in SI, with no significant differences between the groups. Figure 3 shows the perceived physical exertion of a typical lesson conducted by FI and SI. About 50% of the SI group and 60% of the FI group reported feeling that their typical lesson was physically “hard”, with no significant differences between groups. A significantly higher percentage of SI participants described the physical exertion of their lesson as “very hard” ($p=0.042$ between groups, χ^2 test for percentages).

Discussion

To the best of our knowledge, the present study is one of the first that investigated the prevalence of occupational disorders among FI and SI. In particular, we observed that FI had a higher 2-year prevalence of musculoskeletal occupational disorders, whereas SI experienced more acute and chronic voice disorders. Moreover, since FI and SI have to cope with physical exertion and psychic stress, we provide objective data on their physical fitness level and workload during a typical working day.

Regarding musculoskeletal disorders, we observed that that muscle tightness (i.e. a shortening of a muscle), with ankle, knee and wrist sprains, shoulder dislocation, contusions, low back pain, and articular pain were very common in FI. Our results are in line with previous findings among FI [3-5, 7, 15]. Hickey & Hager [15], showed that the most common chronic injuries in aerobic dance instructors were tendinitis, repetitive strain injury, patello-femoral diseases, and medial tibial syndromes, followed by ankles sprain and low-back pain as suggested by Rothenberger et al. [3]. Also, du Toit et al [4] and Bratland-Sanda et al. [7] reported that the lower limbs extremity injuries were very common with the ankle (32.8%) and the knee (20%) as the most common site of injury. Generally, these types of injuries are classified as overuse injuries, resulting from repetitive force applied to a one tissue, joint, or ligament. To this regard, Bratland-Sanda [7] stated that the greater risk of lower limb musculoskeletal disorders in FI is related with the monotonous exercise modality, which is a primary risk factor for overuse injuries. In addition, Shol & Bowling [16] reported high-intensity training classes, unsuitable floors, shoe type, high number of workouts per day, difficult choreography, and insufficient warm-up are among the factors that may contribute to a higher lower limbs occupational disorders. Finally, Sharff-Olson [17] indicated that also the working weekly classes were detected as one of the variables associated with musculoskeletal disorders. In fact, 4 aerobic dance sessions per week increased the injury percentage from 43% to 66% compared to subjects who exercised 3 times per week or less [17]. On the contrary we found that SI had a lower prevalence of musculoskeletal occupational disorders. This was not unexpected because SI work is

largely standing (e.g. classic swim classes) or anti-gravitational (e.g. during water immersed aerobic classes).

With regard to the other disorders, the present investigation found that both FI and SI are at higher risk of developing both acute and chronic voice difficulties associated with the development of sore throat, aphonia and bronchitis. These results corroborate previous research, which found that 58% and 12% of group fitness instructors experience hoarseness and voice loss immediately following classes [17]. It seems reasonable to associate these infections with the typical demands of the job that require loud verbal instructions while performing exercise making the control of breathing and airflow movement more stressful. In fact, it has been demonstrated that the interaction between both environmental and physiological stress leads FI and SI to assume a hyper-functional behavior that could also be worsen by postural misalignment, breathing patterns, work environment and therefore the adoption of compensatory voicing behaviours [18]. This has been observed especially in young and inexperienced instructors, who can also develop voice overuse and laryngeal diseases in the long run [19]. Another incidental factor may be the poor air quality (e.g. dryness, dust) in the workplace that may cause allergic reactions or sinus infections [20]. Finally, the use of chlorine-based products to sanitize swimming water in SI daily life may affect the respiratory health of SI [21]. Moreover, we observed that SI are at higher risk to develop headache and warts compared to FI. Regarding headaches, we hypothesize that the warm temperatures and humidity typical of swimming pool environments may play a role, especially in individuals prone to migraine attacks [22]. For what regard warts it is well known that swimming pools may be a more favorable environment for these types of infections [23].

Regarding the secondary outcome of the study, we are now able to give evidence about physical fitness, and daily workload of FI and SI. In particular, we found that FI and SI showed the same O_{2max} during graded maximal test and HR during a typical workday. Therefore, the aerobic fitness level was comparable between FI and SI subjects, suggesting that both groups are probably exposed to a similar workload, and thus training, during a workday. Our results are similar with those found in the study of Wanke et al. [24], who studied the work related cardiovascular loads in professional dance teachers. In particular they found that depending on the dance style (e.g. jazz, modern dance, ballet etc.) the average HR load during the lessons ranged between $56.7 \pm 7.4\%$ and $63.6 \pm 9.8\%$ of the individual HR_{max} . Interestingly, among women we found a significantly higher HR_{mean} during a typical working day in SI with respect to FI. To this regard, we could speculate that it might be possible that women SI are more often involved in Aqua Gym classes or similar training sessions, which require an active physical participation from the instructor, with respect to men SI, who are more likely to be devoted to swimming instruction or training, which doesn't include an active physical involvement.

This study had some limitations. First, the questionnaire we proposed was custom-made and has not been yet validated nor was checked for internal consistency. After its design, the questionnaire was only submitted to a small group of fitness experts, who evaluated whether the questions effectively captured the topic under investigation. However, the data retrieved with this questionnaire has therefore to be considered as pilot data.

Second, because of the paucity of research in this area, the first part of this study was designed as a cross sectional and exploratory. Although this design is less expensive and can be performed in a shorter period of time, some confounding factors such as history of injuries and work habits prior to data collections cannot be controlled. Therefore, antecedent-consequent relationship, as well as occupational disorders and relative risk, cannot be established through this design. Third, it was not possible to perform analysis on differences between respondents and non-respondents. A possible selection bias was that the prevalence of injuries and musculoskeletal pain might be higher among the respondents compared with the non-respondents, thus affecting the results and the external validity of the study. Finally, self-reporting of injuries and musculoskeletal pain is also a limitation, since this method makes it impossible to verify the injury location and type by a third party. However, the assessment of physical fitness of FI and SI, as well as daily workload and their perceived exertion, are valuable information for focus and design of future studies. To this regard, it is suggested that future researches consider these factors to conduct stronger longitudinal studies about this topic.

Conclusions

In conclusion, a higher 2-year prevalence of instruction-related musculoskeletal disorders and vocal pathologies in FI and SI was observed. The role of work environment should therefore be considered as an occupational hazard. Practical advice for FI and SI professionals would be setting up guidelines regarding maximum weekly instruction loading.

Declarations

Acknowledgments

The Authors would like to dedicate this work in loving memory of Prof. Arsenio Veicsteinas, who recently passed away. He conceived and designed this study along with many other experiments. He inspired all of us and remains a shining example with his visionary and open-minded approach to science and everyday life. Moreover, the authors wish to thank all the people recruited for the study and for their committed participation.

Author Contributions

M.A.M. designed the study (with Prof. Arsenio Veicsteinas) and performed the data collection; M.B., L.A., G.M. analysed the data, and together with D.G. wrote up the manuscript. M.A.M and M.B. did the critical revision of the manuscript. All authors contributed and gave their approval for the final version of the manuscript submitted for publication.

Ethics approval and consent to participate

The study protocol was approved by the Scientific and Technical Committee of the ISPESL (Istituto Superiore Prevenzione e Sicurezza sul Lavoro, Italian Ministry of Health, n° B19/DOC/03), and was

conduct in adherence to current national laws and regulations governing the use of human subjects (Declaration of Helsinki III). Participants were fully informed of the procedure and signed an informed consent form outlining the study protocol, benefits, and risks associated with participation.

Availability of data and materials

The datasets analysed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Competing interests

The authors have no conflicts of interest to declare.

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Figures

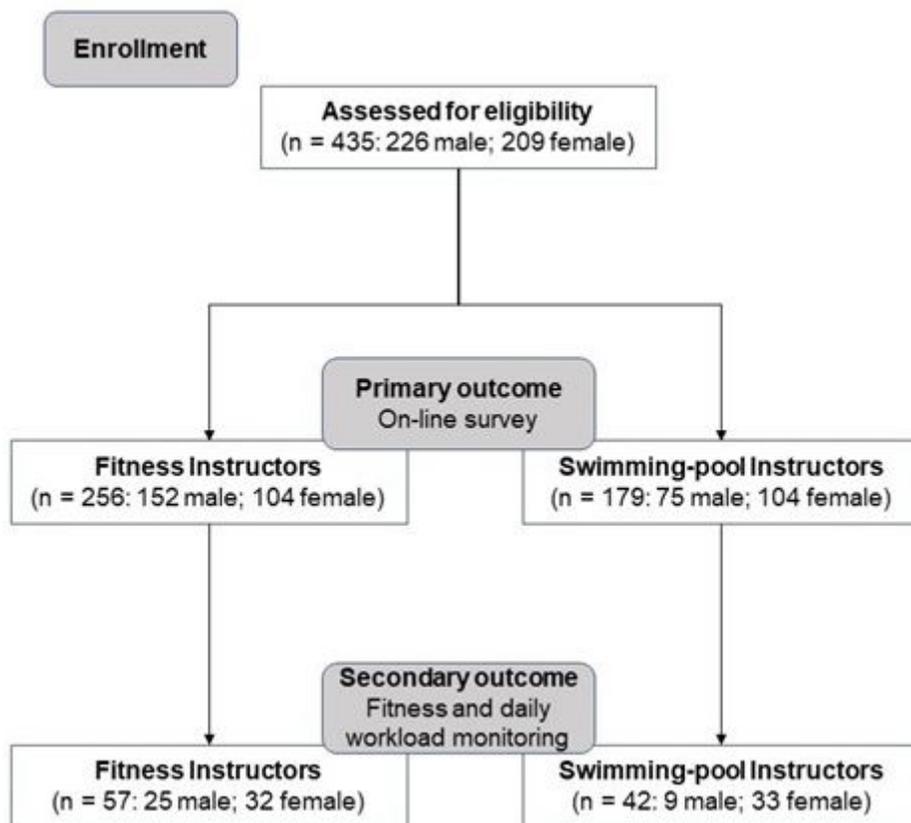
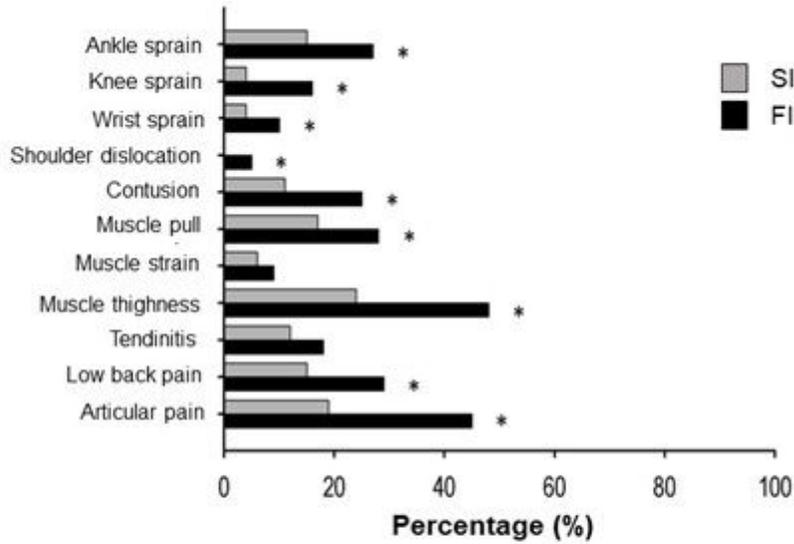


Figure 1

Study flow diagram.

Musculoskeletal Disorders



Other Disorders

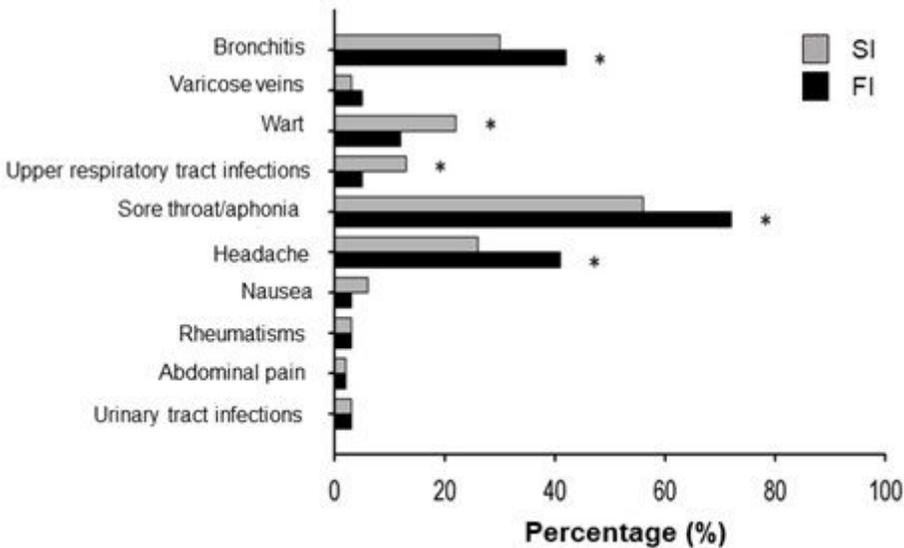


Figure 2

The figure represents the proportions of individuals of each group (FI and SI), who experienced during the last 2 years each specific musculoskeletal injury or other disorders. Legend: *, $p < 0.05$.

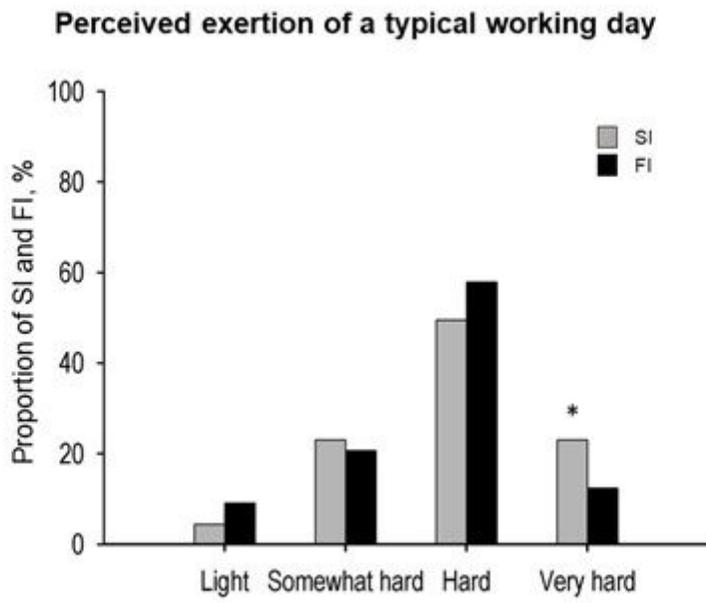


Figure 3

Perceived exertion of a typical lesson. Legend: *, $p < 0.05$.