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

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Abstract

Background. Fitness (FI) and swimming instructor (SI) are two different type of trainers that are usually employed in fitness centers and their profession is highly physically demanding because they have to exercise while teaching. To date, data on occupational disorders in FI are limited and there is no information about SI. Therefore, the primary outcome of this study was an exploratory analysis of occupational disorders experienced by FI and SI employed in various fitness centers through a self-reported questionnaire, to provide first data on its prevalence. 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 professional activities.

Methods. An online cross-sectional survey addressing physical data, frequency, duration and time of class participation and self-reported occupational disorders was conducted among 435 subjects (FI=254; SI=179). Subsequently, 97 subjects (FI=57; SI=42), were enrolled to investigate physical fitness by maximal oxygen consumption ($\text{BO}_{2\text{max}}$), and daily workload by heart rate (HR) and rating of perceived exertion (RPE).

Results. A total of 621 musculoskeletal disorders and 521 of other disorders were included in the study with 157 and 155 participants that experienced 2 or more injuries during the last 2 years of their career, respectively. FI exhibited a higher prevalence of musculoskeletal injuries and SI experienced more upper respiratory tract infections. $\text{aO}_{2\text{max}}$ ranged from 47.0 ± 4.0 to $51.9 \pm 3.7 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, and no statistically significant differences between sex and instructor type was found. No statistical differences between instructor type in HR_{mean} and $\text{HR}_{\text{mean}}/\text{HR}_{\text{max}}$ was found. According to sex, female SI displayed significantly higher HR_{mean} and $\text{HR}_{\text{mean}}/\text{HR}_{\text{max}}$ ($p=0.018$, $p=0.022$, respectively) than female FI.

Conclusions. In conclusion, FI and SI experienced a high prevalence of musculoskeletal and occupational disorders. Moreover, data on FI and SI physical fitness and daily workload monitoring will help to set up guidelines regarding maximum weekly teaching load.

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 costumers can find lots of equipment for cardio and weight training or group fitness classes. In swimming pool centers costumers can find different types of swimming classes as well as water aerobics courses. Fitness (FI) and swimming instructors (SI) are therefore two different type of trainers that are 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 teach group classes in which organize and lead fitness classes lasted 30-90 minutes. In these classes, instructors

may set the music and choreograph in exercise sequence, 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, most of the time they have to practice while teaching and they may work nights, weekend, or holidays or have to travel to different gyms or to clients' home to teach classes or to conduct personal training sessions. 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 those subjects injured, 23% reportedly saw a physician because of their injury. The frequency with which subjects exercised was associated with a 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 prevalence numbers 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 had experienced injuries related 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 the group fitness instructors.

In addition, FI and SI rely on their voices in a similar way that 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 when that are encountered when speaking and vigorous exercise occur simultaneously [9]. For this reason, 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 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 are no information about SI, the primary outcome of this study was to investigate the 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 prevalence of occupational disorders experienced by FI and SI, a retrospective cross-sectional self-reported observational study was conducted. Subsequently, in order to investigate physical fitness and daily workload during a typical working day in FI and SI a prospective cross-sectional observational study was performed.

Participant screening

Participants were recruited from various fitness centers companies (Get Fit, 20 Hours, Virgin Active). These companies 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 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 sand 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 online 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 their entire career were asked by answering the following question: "Have you experienced any occupational disorder as FI or SI in the last 2 years of your career?" [7]. If positive response, participants have to specify each injury, type of injury (acute/overuse), in accordance with the definitions provided by the consensus statement regarding disorder registration [12]. 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. The administered questionnaire, after English translation, is available as supplementary material.

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 Ergonomic 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. In particular, FI and SI were instructed to wear it before the start of their classes and to remove it at the end of the last lesson of the day. For the subsequent analysis, the central 3 hours of this workday has been considered to standardize results, by selecting an equal time frame for all participants, and excluding preparation and conclusion periods, that can differ among activities. 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 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 the last lesson 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, the perceived exertion 30 minutes after the end of their lessons, and the perceived exertion and fatigue upon waking up in the morning. Intra- and intergroup differences (gender $\times$ 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 (ANOVA) 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

Four-hundred and seventy-two participants were invited to complete the on-line survey. Thirty-seven participants did not fill correctly the survey and they were excluded from the analysis. Therefore, 435 instructors were included in the study. Consequently, the response rate was 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 included in the study with 157 and 155 participants that experienced 2 or more injuries for during the last 2 years of their career respectively. As the majority of participants (>50%) showed a career duration < 5 years, we assumed that the answer related to the last 2 years may reflect the whole career duration of participants; the selection of the 2 last years was done also to avoid recall bias, because participants with career longer than 5 years might be unable to remind everything since the beginning of their career.

Figure 2 illustrates the prevalence of occupational disorders that occurred during the FI and SI entire 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

Table 2 shows heart rate at rest (HR_{rest}), maximal heart rate (HR_{max}), and O_{2max} results during cardiorespiratory fitness testing in FI and SI according to the gender. Two-way ANOVA with Bonferroni's multiple comparisons test did not show any interaction and statistical differences between sex and instructor type in HR_{rest} , HR_{max} and O_{2max} .

Daily Workload Monitoring Results

Table 2 shows average heart rate (HR_{mean}) and the ratio between HR_{mean} and HR_{max} (HR_{mean}/HR_{max}), during 3 hours of the daily workload monitoring. Two-way ANOVA with Bonferroni's multiple comparisons test did not show any interaction and statistical differences between instructor type in HR_{mean} and HR_{mean}/HR_{max} . No significant main effect between male SI and FI was found. However, 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
$\dot{V}O_{2max}$ (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. $\dot{V}O_{2max}$, 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 fatigue 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 fatigue) [14] in FI and 72.0 ± 18.0 AU in SI, with no significant differences between the groups. Figure 3 shows the perceived physical fatigue 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 prevalence of instruction related musculoskeletal occupational disorders, whereas SI experienced more acute and chronic voice disorders. Moreover, since FI and SI have to cope with physical and psycho-mental we provide objective data on their physical fitness level and workload during a typical working day.

Regarding musculoskeletal disorders, we observed 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 considered classified as chronic 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 limb 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 less 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 occupational 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 behaviors [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 respect 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. O_{2max} ranged from 47.0 ± 4.0 to $51.9 \pm 3.7 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$. In accordance with their age and sex, males FI and SI are between the 70-90 percentiles and female FI and SI are above the 90th percentile of the reference standards for cardiorespiratory fitness measured with cardiopulmonary exercise testing using cycle ergometry [24]. We observed that SI and FI did not differed in O_{2max} during graded maximal test, 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. [25], 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 significant difference about HR_{mean} during a typical working day. To this regard, we could speculate that it might be possible that women are more involved in Aqua Gym or activities that include an active physical participation with respect to men that maybe are more devoted to swimming instruction or training which doesn't include an active involvement.

This study had some limitations. 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. Second, 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. Third, self-reporting of injuries and musculoskeletal pain is also a limitation: we could not ask any of the subject for the medical record. In addition, the self-reporting method makes impossible to verify also the right location and type of the injury. Therefore, no injury severity score was applied. However, it should be emphasized that this was only a preliminary and descriptive investigation; nevertheless, the results obtained are scarcely available in the literature and can highlight an aspect relating to these poorly protected self-employed workers.

Conclusions

In conclusion, a high prevalence of instruction-related musculoskeletal, occupational disorders and vocal pathologies was observed during FI and SI career. These disorders are probably a consequence of their physically demanding work activities and especially for SI of the work environment. Therefore, data on FI and SI physical fitness and daily workload monitoring will provide useful information in order to better focus and design future studies. Moreover, this information will help to set up guidelines regarding maximum weekly teaching load in these workers.

Declarations

Acknowledgments

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Author Contributions

M.A.M. designed the study (with Prof. Arsenio Veicsteinas) and performed the data collection; M.B., L.A., G.M. analyzed 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 analyzed 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 two years of their career each specific musculoskeletal injury or other disorders. Legend: *, $p < 0.05$.

Figure 3

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

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [ANNEX1QuestionnaireEN.pdf](#)
- [ANNEXQuestionnaireIT.pdf](#)