



Physical Activity Monitoring Model to Measure the Appropriateness of Weekly Physical Activity for the World Health Organization's Physical Well-Being and Health Claims

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Abstract

Objectives. The study aimed to test an agile monitoring tool to correlate physical activity levels for the 2 target age groups of school education with energy consumption.

Materials and methods. The sample consisted of 42 students, divided into two age-based groups: between 5 and 8 years of 24 and between 13 and 16 years of 18. Both were administered the adapted International Physical Activity Questionnaire (IPAQ), comprising ten questions, the first of which distinguished active athletes from others participants. The remaining nine questions were divided into sections: "intense activities", "moderate activities", and "walking only". The data on the amount of physical activity undertaken in the past seven days were converted to energy expenditure through the evaluative unit of Metabolic Equivalent of Task (MET).

Results. For subjects between 5-8 years who were active in sports, the weekly average was 3355.2 METs, with 1577 for intense activities, 1617 for moderate activities, and 159.7 for walking. Among subjects in the 13-16 years age group who were active in sports, the weekly average was 3799.5 METs, with 3376 for intense activities, 577.6 for moderate activities, and 529.9 for walking. For the same age group who were not engaged in sports activity, the weekly average was 594.5 METs, with 20 for intense activities, 360 for moderate activities, and 214.5 for walking.

Conclusions. The findings show that it is possible to use the physical activity monitoring tool proposed in the study, with the measurement of METs.

Keywords: caloric consumption, metabolic equivalent of task, questionnaire.

Introduction

Daily caloric consumption is defined as a measure of the amount of energy an individual uses during daily activities (Taylor & Keys, 1950). It is considered a key element in the common understanding of physical activity levels (Shock, 1972). This is confirmed by the introduction of compulsory teaching of physical education by the teacher with a master's degree in exercise science to bring down the levels of

overweight and obesity in the Italian population (Cole et al., 2000; D'Isanto, 2019; Raiola et al., 2018). This measure was reinforced with the strengthening of physical education and sports with the reinstatement of the Youth Games. In addition, the educational and social value of physical activity, as well as its psychophysical effects for proper health education and psychophysical well-being, has been included in the Italian Constitution (Gazzetta Ufficiale, 2022). The age variable is crucial in school education to better understand physical activity levels (Raiola, 2017). This is especially important during the first cycle of elementary school and the first cycle of secondary school (Raiola, 2020). During these periods, children and adolescents may develop habits

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related to physical activity that will influence their daily lives. It is essential to gain knowledge about these levels during these stages of growth, as this can have a significant impact on their life habits and future health (Taylor et al., 2014). Numerous studies have amply demonstrated the importance of practicing physical activity (Chatzipanteli et al., 2015; Pethkar et al., 2010; Esposito, 2024) accompanied by the already expected evidence on the educational function of movement (Raiola, 2019). In fact, such studies show that physical activity produces positive effects on those who practice it on a physical level, having beneficial effects on the cardiovascular system, preventing hypertension, helping to control weight (Beunen et al., 1981). Understanding, even superficially, caloric consumption is not limited to static assessment, but requires continuous monitoring in the context of daily activities and, therefore, should be introduced into school education (Aliberti, 2023). A dynamic and timely assessment of energy consumption is essential to combat sedentariness and to initiate accurate identification analyses (Raiola, 2015; Raiola, 2014). The study of caloric expenditure is also crucial for developing personalized, evidence-based weight management strategies (Castro et al., 2020; Fischer & Johnson, 1990). In scientific literature, no agile tools are found that allow monitoring of calorie expenditure because of congruous physical activity for the purpose of mental and physical well-being as indicated by the World Health Organization (WHO) and recently included in the Italian Constitution.

Purpose of the research – The main objective of this study is to test a new agile monitoring tool that is efficient and flexible to establish a correlation between physical activity levels and energy consumption. This tool will be applied to two target age groups in school education, thus enabling a detailed overview of children's and adolescents' physical activity habits.

Materials and Methods

Study Participants

Forty-two students participated in the study, divided into two groups according to their age group: between the ages of 5 and 8 composed of 24 units, corresponding to the early years of primary school education, and between the ages of 13 and 16 composed of 18 units, corresponding to the early years of secondary school education. The sample was selected randomly.

Study Organization

A questionnaire was developed, adapting a version of the International Physical Activity Questionnaire (IPAQ) for the purpose. The latter's main objective is to assess the type and frequency of physical activity performed during the last week of the subject under study. Due to the age of the sample, for both the 5-8 age group and the 13-16 age group, the responses are made by the parents of the study participants. It contains ten questions, the first being useful in creating a division between those who play sports and those who do not. The next four questions have been divided into two different sections. In the "intense activity" section. In the "intense activity" section, subjects were asked whether they had engaged in intense physical activity in the past seven days and for how many minutes. Intense activity is defined as that type of activity that involves high physical exertion that forces breathing at a much higher rate than normal. In the moderate activity section, subjects were asked whether they had engaged in moderate physical activity in the past seven days and for how many minutes. Moderate physical activity is defined as that type of activity that involves moderate physical

Table 1. Questionnaire

Questions	Answers
Do you practice sports? (Practicing sports is defined as engaging in structured sports activity for at least 2 days a week of 1h 30min each)	-Yes -No
1A) In the past 7 days, on how many days did you engage in intense physical activities such as sports training, aerobic activities such as running or bicycling at high speed?	(Indicate the number of days, if the answer is zero go to question 2)
1B) How much time in total did you normally spend performing intense physical activities on any of these days:	(Indicate the number of minutes)
2A) For how many days in the past 7 days did you engage in moderate physical activities, such as playing in the park, riding a bicycle at a regular speed?	(Indicate the number of days. Do not consider walks)
2B) How much time in total did you normally spend doing moderate physical activities on any of these days?	(Indicate the number of days)
3A) In the last 7 days, how many days did you walk for at least 10 minutes? Consider any walking for a move from one place to another	(Indicate number of days per week, if zero go to question 4th)
3B) How long in total did you normally walk on any of these days?	(Indicate number of minutes)
3C) At what pace did you predominantly walk?	-Intense pace -Moderate pace -Slow pace, without any change in respiratory rate
4A) In the past 7 days, how much time in total did you spend sitting during a weekday?	(Mean time spent at school, at home on the couch, at the table) Give the number in hours.
4B) In the past 7 days, how much time in total did you spend sitting during a weekend day?	(Indicate the number of hours)

exertion and only partially forces breathing at a higher rate than normal. Once the type and amount of physical activity performed by the subjects surveyed had been analyzed, in the “walking” section we proceeded to investigate whether they had walked for at least 10 minutes in the past seven days, meaning it as moving from one place to another, and in the case of an affirmative answer they were asked how many minutes in a day they had walked. The last question was about the sustained pace in walking, slow, moderate or intense. The last section of the questionnaire, called “sitting activity,” on the other hand, concerns the hours participants spent sitting on any of the weekdays, for example, hours spent at school and hours spent sitting on any of the week-end days. All this is shown in Table 1.

Once the questionnaire is administered, the results are analyzed using the International Physical Activity Questionnaire (IPAQ) interpretation table, which is used to understand whether a subject is:

- Active: performs an optimal amount of physical activity;
- Sufficiently active: performs sufficient physical activity to maintain physical well being;
- Inactive: does not engage in sufficient physical activity to maintain good health.

The table is based on the Metabolic Equivalent of Task (METs), useful values for quantifying the energy consumed during physical activity; one MET corresponds to 1 Kcal per kg body per hour. Through mathematical formulas physical activity energy consumption divided by resting energy consumption, the METs that each individual consumes during intense, moderate physical activity and in walking are calculated. The sum of these METs gives the total weekly energy consumption. If the total weekly METs is less than 700, the individual is found to be inactive; if it is between 700 and 2519 METs, the individual is considered sufficiently active; if it exceeds 2520 METs, the individual is classified as active or very active. If the total is less than 700 Met: INACTIVE. If the total is between 700 and 2519 Met: SUFFICIENTLY ACTIVE. If the total is more than 2520 Met: ACTIVE OR VERY ACTIVE. This is summarized in Table 2.

Table 2. METs (Metabolic Equivalent of Task) Table, interpretation of the questionnaire

METs (Metabolic Equivalent of Task) Table, interpretation of the questionnaire
Met intense activities = minutes * days * 8 Met
Met moderate activities = minutes * days * 8 Met
Met activity walk = minutes * days * 3 if moderate, *3.3 if intense, *2.5 if slow
Total Met = Met activities together + Mett activites moderate + Met walks =...

Statistical Analysis

Descriptive statistics was used in data analysis to examine mode, mean, median and standard deviation. It was verified that the data had an approximately normal distribution. Statistical processing was conducted using SPSS statistical software, ensuring accurate and detailed analysis of the results.

Results

From the analysis of the results, it was found that to the first question, that is, ‘Do you practice sports?’ 66.6 % of the respondents practice sports, 33.4% do not as shown in Table 3. In terms of numbers out of 42 participants 28 subjects practice sports and the remaining 14 do not.

Table 3. Percentage sportsmen and non-sportsmen

Percentage sportsmen and non-sportsmen	Total sample	Age group 5-8 years	Age group 13-16
% Athletes	66.6	90	46
% Not athletes	33.4	10	54

In the “intense activities” section to the question regarding physical activity that was performed intensively in the subject's last 7 days, considering only the answer “0,” the percentage of individuals who did not perform it stands at 18.8%. When analyzing the total minutes that individuals spent performing intense physical activity, it is found that the average value is 110 minutes, in a range from 90 to 130 minutes, with only 4 individuals performing intense activity for less than this range, which is 75 minutes, and only two individuals performing activity for 180 minutes, exceeding the previously mentioned range. Going to analyze the “moderate activity” section, all participants say they have done moderate physical activity in the past 7 days, 14.3% say they did it for only one day while only 9.5% did it for 7 days. The average number of days on which moderate physical activity was done in the last 7 days is 3.5 days. Next, the total minutes devoted to moderate activity was analyzed. The peak number of minutes recorded for a single individual is 240. The average number of minutes spent in moderate physical activity is 77.4. In the “walking” section 32 individuals, or 76.2% of respondents say they have walked for at least one day in the past 7 days. 25% walked for 3 days, 12.5% walked only one day, and 18.8% walked every day. Respondents in 33.3% indicated that they walked within a day for a total of 20 minutes, 13.3% for 15 minutes. The highest figure corresponds to 75 minutes, time spent by 6.7% i.e., two individuals. The average number of minutes spent walking is 26.6 minutes total. The last question in the “walking” section was analyzed by the pace at which individuals did their walking. 0% voted intense pace, while 68.8% indicated walking at a slow pace and 31.3% at a moderate pace. The last data that was analyzed concerns the total time an individual spent sitting on a weekday in the last 7 days, the figures that appear most, indicated by 19% respectively are 7 hours, 8 hours and 10 hours. The average time spent sitting is 6.8 hours per day. On a weekend day, 19% of respondents reported sitting for a total of 4 hours and 6 hours, fashion data. The average number of hours individuals spent sitting on a weekend day is 5 hours. Analyzing the totality of the sample taken, the average METs consumed in intense activities is 1485.7 METs weekly, the average METs consumed in moderate activities is 950.8, while in walking on average 255.9 METs are consumed in a week. The average METs that are consumed in total is 2691.5 weekly. Considering only the class of those who practice sports in the 5-8 years age group, the average METs consumed in intense activities is 1577, METs consumed in

Table 4. Calculation of the average METs

Calculation of the average METs	Total sample	Age group 5-8 years who play sports	Age group 5-8 years who do not play sports	Age group 13-16 years old playing sports	Age group 13-16 years who do not play sports
Mean METs att. Intense	1485.7	1577	0	3376	20
Mean METs moderate att.	950.8	1617	360	577.6	360
Mean METs walk	255.9	159.7	0	529.9	214.5
Mean METs total	2691.5	3355.2	360	3799.5	594.5

Table 5. Percentage of active and inactive subjects

Percentage of active and inactive subjects	Total sample	Practice sports	Not practice sports	Age group 5-8 years old	Age group 13-16 years old
%inactive	23.8	0	100	0	100
%Suff. active	19	50	50	50	50
%Super active	57.2	100	0	58.3	41.6

moderate activities is 1617, and the average METs consumed in walking, on the other hand, is 159.7. Finally, the average total METs that are consumed in a week is 3355.2. For the class of those who play sports in the 13-16 range, the average of METs consumed in intense activities is 3376. The average of METs consumed in moderate activities is 577.6, the average of METs consumed in walking 529.9. The average of total METs consumed in a week is 3799.5. In the 13/16 range, the average METs consumed by nonsports people in intense activities is 20, in moderate activities is 360. The average METs that are consumed in walking 214.5. Finally, the average total METs consumed over a week is 594.5. This can be seen in Table 4.

In the 42 subjects surveyed as a whole, 23.8 %, are found to be inactive; on the other hand, 19 % are found to be sufficiently active, while the remainder, 57.2 % are found to be very active. 100 % of those who are inactive do not play sports and are in the 13-16 age group. The percentage of those who are sufficiently active is divided 50 % between those who play sports and those who do not. The percentage of those who are found to be very active and play sports is 100 %. All this can be noticed in Table 5.

Table 6 shows the percentage increase in the consumption of METs that occurs in the 13-16 age group compared to the 5-8 age group, considering only those who participate in sports. Total METs, consumed in intense, moderate and walking activities, are considered. In intense activities the increase in METs is 114 %, in moderate activities -179.9 %, in walking 107 %, and finally in the total account of METs consumed in a week the increase is 13.2 %.

The total METs consumed in one week in the 13-16 age group by those who play sports is 3204.5 greater than those

who do not play sports. In the analysis of METs consumed in intense activities, the difference stands at 3356 METs in favor of those who play sports. In moderate activities, on the other hand, those who play sports consume an average of 217.6 METs more than those who do not. Finally, in walking, the difference is 315.4 METs in favor of those who practice sports. This has been reported in Table 7.

Table 7. Total METs consumed in a week

Total METs consumed in a week	
Mean difference METs consumed in intense att.	3356
Mean difference METs consumed in moderate attitudes	217.6
Mean difference METs consumed in walking	315.4
Mean difference METs consumed	3204.5

In the 13-16 age group, there is a 500 % increase in those who do not participate in sports compared to the 5-8 age group. Finally, the average hours individuals spend sitting on weekdays and holidays was analyzed. The analysis shows that on weekdays children in the 5-8 age group who play sports on average sit 7.1 hours compared to 8 hours for those who do not play sports, while on holidays those who play sports on average sit 3.6 hours; those who do not play sports 10 hours. In the 13-16 age group, those who play sports on weekdays sit an average of 7.2 hours, compared to 8.1 hours for those who do not play sports, while on holidays those who play sports on average sit 4.4 hours; those who do not play sports 7 hours. As demonstrated in Table 8.

Table 8. Mean hours sitting

Mean hours sitting	Age 5/8 Sport yes	Age 5/8 Sport no	Age 13/16 Sport yes	Age 13/16 Sport no
Mean hours sitting on weekdays	7.1	8	7.2	8.1
Mean hours sitting on holidays	3.6	10	4.4	7

Discussion

Two age groups were considered in the results section: individuals between 5 and 8 years old and individuals

Table 6. Percentage increase in the consumption of METs

Percentage increase in the consumption of METs	In the 13-16 athletes
Increment % METs att.intense	114
Increment % METs att.moderate	-179.9
Increment % METs walk	107
Increment % METs total	13.2

between 13 and 16 years old. The data collected shows that about 60 % of individuals in these age groups practice sports regularly, a result in line with what was reported in the ISTAT surveys. This finding is also reflected in the sample surveyed, where 66.7 % of respondents say they play sports. The WHO guidelines recommend intense physical activity of at least 60 minutes a day for at least three days a week for these age groups, flanked by moderate activity on the other four days (D'Elia et al., 2019). However, only 33.3 % of respondents engage in intense activity according to these guidelines, although the total duration of physical activity exceeds the requirement set by the WHO for the entire sample. As for moderate activities, all participants report doing them, but the average number of days devoted to them is slightly lower than recommended by the WHO. The latter also emphasizes the health benefits of walking at a moderate pace, recommending at least 30 minutes a day on all days of the week. However, only a minority of respondents say they walk every day, with the average amount of time spent on walks not fully meeting WHO guidelines (D'Elia, 2020). An analysis of METs consumed in various activities shows that individuals who participate in sports tend to consume significantly more than those who do not, in all age groups considered. In particular, there is a significant increase in METs consumed in the 13-16 age group compared to the 5-8 age group, with the exception of moderate activities. In the 5-8 year age group, in intense activities, sports children consume 1577 METs weekly compared to 0 for those who do not participate in sports. The value 0 is also found in the METs consumed by those who do not participate in sports in the walk analysis. Sportsmen consume 159.7 METs per week by walking. In moderate activities, sportsmen consume 1617 METs, those who do not participate in sports 360. Comparing the total METs that are consumed by those who play sports and those who do not play sports will show that those who play sports consume 9.32 times the METs of those who do not play sports in a week. Even in the age group of 13- to 16-year-olds, the basic thesis would seem to be confirmed. In fact, on average in intense activities, those who practice sports consume 3376 METs weekly compared to 20 METs consumed by those who do not. The METs consumed in moderate activities also confirm this, 577.6 is the average METs that sportsmen consume weekly, only 360 on the other hand are consumed by those who do not practice sports. In walking, those who play sports consume 529.9 METs, while those who do not practice sort consume 214.5, less than half. In tallying the total METs consumed on average in a week, the trend is confirmed in that sportsmen in the age group 13-16 consume an average of 3799.5 METs compared to 594.5 for those who do not practice. The difference is as much as 3205 weekly METs. We now consider data regarding METs consumed only by those who participate in sports, comparing those consumed by subjects in the 5-8 range and subjects in the 13-16 range. In the tally of METs spent on average in the intense activities, in those in walking, and in the total calculation of the week, it will be possible to see a marked increase in METs consumed in the adolescent group compared to the preadolescent group. Only in moderate activities will the METs consumed decrease, from 1617 in the 5-8 range to 577.6 in the 13-16 range. Finally, there is an increase in time spent sitting on holidays compared to

weekdays, with a more pronounced difference between those who play sports and those who do not, especially in the 5-8 age group.

Conclusion

The study investigated the importance of caloric consumption as a key indicator for assessing physical activity levels, focusing on two age groups in developmental age. It was found that a defined agile monitoring tool can be effective in assessing physical activity measured in METs. This is evident from the results that provided insight into whether a subject was inactive, sufficiently active, or very active. However, the sample size is a limitation that requires expansion. Nevertheless, the study indicates potential opportunities in the field of tracking and monitoring physical activity, thus contributing to the effectiveness of school education on mental and physical health and well-being.

Conflict of interest

The authors declare that there is no conflict of interest.

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Модель моніторингу фізичної активності в контексті вимірювання відповідності рівня щотижневої фізичної активності вимогам Всесвітньої організації охорони здоров'я щодо фізичного благополуччя та стану здоров'я

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 8 табл., 21 джерел.

Мета дослідження. Мета цього дослідження полягала в перевірці використання гнучкого інструменту моніторингу щодо кореляції рівнів фізичної активності для 2 цільових вікових груп шкільної освіти з енергоспоживанням.

Матеріали та методи. Вибірка складалася з 42 учнів, розділених на дві вікові групи: 24 особи віком від 5 до 8 років та 18 осіб віком від 13 до 16 років. Обом групам було запропоновано адаптований Міжнародний опитувальник фізичної активності ("International Physical Activity Questionnaire", IPAQ), що включав десять запитань, перше з яких давало змогу відрізнити активних спортсменів від інших учасників. Решта дев'ять запитань розподілялися за розділами: «інтенсивні навантаження», «помірні навантаження» та «виключно ходьба». Отримані дані щодо кількості фізичної активності, виконаної за останні сім днів, конвертувалися у витрати енергії за допомогою оціночної одиниці метаболічного еквіваленту навантаження (MET).

Результати. Для осіб віком 5-8 років, які активно займалися спортом, середньотижневий показник становив 3355.2 MET, з яких 1577 для інтенсивних навантажень, 1617 — помірні навантаження і 159.7 — ходьба. У віковій групі 13-16 років, які активно займалися спортом, середньотижневий показник складав 3799.5 MET, з яких 3376 для інтенсивних навантажень, 577.6 для помірних навантажень і 529.9 для ходьби. Для учасників аналогічної вікової групи, які не займалися спортом, середньотижневий показник становив 594.5 MET, з яких 20 — інтенсивні навантаження, 360 — помірні навантаження і 214.5 — ходьба.

Висновки. Результати дослідження показали можливість використання запропонованого в роботі інструменту моніторингу фізичної активності, що включало в себе вимірювання показників MET.

Ключові слова: споживання калорій, метаболічний еквівалент навантаження, опитувальник.

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