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**Research article**

# Evaluation of the Physical Activity Biography: Sport and Transport

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**Abstract**
Beside the genetic disposition, physical activity (PA) is one of the major health factors and can play a large role in the prevention and therapy of many diseases (cardiovascular diseases, cancer, obesity-related diseases etc.). In contrast to the genetic disposition, PA can be deliberately influenced by lifestyle. Therefore, it is of high importance to assess PA patterns. In order to assess PA–reliably and validly, a new questionnaire (Physical Activity Biography, PAB) was created. The PAB assesses recreational PA (sport and transport) and enables to distinguish between endurance intensity levels and considers strength and high speed activity patterns throughout life. This study aims to evaluate the PAB by means of item analysis, retest-reliability and validity (criteria were physical fitness assessed by the questionnaire FFB-mot and by exercise tests). 141 participants answered the PAB. For deriving retest-reliability, 81 participants completed the PAB after a retest-interval of one month again. 55 participated in exercise tests and answered the FFB-mot to determine construct validity. Retest-reliability (ICC) above 0.7 was found for most items. For the items assessing recent PA, the criteria of convergent and discriminant validity were given. Despite the complexity of the question under study, the results fulfilled the expectations concerning reliability and validity. The PAB enables to assess the amount of sport and locomotion a person has accomplished during different life time frames and, because of the protective effects of PA on various diseases, may become an important tool for risk assessment.

**Key words:** questionnaire; physical fitness; metabolic equivalent; reliability and validity.

## Introduction

The application of physical activity (PA) questionnaires is the most widely used method for the assessment of PA in population studies (LaPorte et al., 1984), and according to Lagerros and Lagiou (2007), questionnaires are the *"method of choice in large epidemiological studies"*.

In 1997, the scientific Journal Medicine & Science in Sports and Exercise devoted a supplement to more than 30 different instruments for self-reported PA (Pereira et al., 1997). A large number of different questionnaires assessing physical activity are obtainable (Mäder et al., 2006, Pereira et al., 1997, Terwee et al., 2010) and new tools continuously appear as a result of the growing interest on PA (Lagerros and Lagiou, 2007). However, *"... most likely due to the fact that physical activity is a complex exposure to measure"* no PA questionnaire can be adequate for every situation and every population (Lagerros and Lagiou, 2007). Terwee et al. (2010) state that many questionnaires are poorly designed and the content and measurement properties are often either unsatisfying, not tested or reported incompletely and the choice of an appropriate questionnaire for a specific task may be difficult (Kriska and Caspersen, 1997; Terwee et al., 2010).

According to Casperson et al., (1985) PA includes *"...any bodily movement produced by skeletal muscles that results in energy expenditure"*. Nevertheless, only few studies up to now have focused on all components of PA (Kriska and Caspersen, 1997; Terwee et al., 2010) , such as sports, transport, occupational physical activity, homework and gardening. The most frequently used German PA questionnaires are the Freiburger Fragebogen zur körperlichen Aktivität (Frey et al., 1999) and the German version of the IPAQ (International Physical Activity Questionnaire, Booth, 2000). However, these instruments only assess recent PA and also include open questions; hence automatic processing and the use in large epidemiologic studies may be difficult.

There are only few questionnaires (Cumming and Klineberg, 1994; Friedenreich et al., 1998; Kriska et al., 1988; 1990) that aim to assess lifetime PA (Chasan-Taber et al., 2002). All of them are designed to be interviewer administered, *"... a technique often not practical for epidemiologic studies conducted among large numbers of participants"* (Chasan-Taber et al., 2002).

There are numerous studies on the relationship between PA and health and there is solid evidence that PA can reduce the risk of developing non-communicable diseases, like cardiovascular diseases, breast, colon and other forms of cancer, type-2 diabetes etc. (Pedersen and Saltin, 2006), and PA can also increase life expectancy (Blair et al., 1996; Kohl, 2001; Lee et al., 2012; Wannamethee and Shaper, 2002). Further, PA also plays an important role in therapy and in rehabilitation of non-communicable diseases (Doyle et al., 2006, Schmitz et al., 2010).

In a recent study (Wen et al., 2011) a multiple choice questionnaire (three questions measuring PA during the previous month) showed that even low-volume PA (15 min per day) was associated with a 14% risk reduction of all-cause mortality and a 3 year longer life expectancy. Application of a questionnaire capable of assessing PA over the whole life might increase the benefits of such a study or related ones substantially because the development of non-communicable diseases is a long-term process which cannot be mapped by means of a questionnaire assessing only recent PA.

For detailed investigations of the effects of PA pat-

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terns on non-communicable disease prevention and therapy, a questionnaire fulfilling the demands summarized in Table 1 is a substantial extension which enables to assess the role of the life-time distribution of PA for preventing or reducing the development of non-communicable diseases. As no existing questionnaire fulfills these demands, we decided to design a reliable and valid questionnaire that can be used for all groups: athletes, healthy people, and also for groups of patients, e.g. cancer patients. We considered assessment of PA over a short and long time period as was suggested by Kriska and Caspersen (1997) in order to obtain the best estimate of PA levels throughout life.

**Table 1. Special demands on the questionnaire.**

| |
|---|
| Suitable for adults and elderly people |
| Assessment of the amount of physical activity |
| Assessment of physical activity intensity |
| Distinction between different types of physical activity |
| Assessment of total physical activity (transport, sport and work) |
| Capable of measuring the amount of physical activity patterns during certain life-time frames (from one's youth till the latest 3 weeks) |
| German language |
| Use of rating scales for automatic processing |

The possibility to distinguish between different types of PA (endurance, transport, speed, strength) a person has carried out in the past can be important for various reasons: (a) to get to know the prevalence of different types of PA of a person and (b) differences in PA patterns between individuals or groups, or (c) to monitor changes of PA patterns after certain training interventions. Furthermore, such a questionnaire can be used to investigate health benefits with respect to different types of bodily training (Bouchard, 2001; van Poppel et al., 2010) and thereby public health recommendations may be improved (Lagerros and Lagiou, 2007): for example, it is still unclear whether there are special types of PA that reduce e.g. cancer risk more than others: *"To date, there is no suggestion that one type of physical activity provides greater benefit than another*" (Wolin and Tuchman, 2011) and *"...the precise exercise prescription, in relation to type, intensity, duration and frequency needed for cancer protection remains unknown"* (McTiernan, 2003).

## Methods

### The physical activity biography

Several considerations and pilot studies preceded the questionnaire described below in order to eliminate or reduce possible problems as early as possible. The PAB measures a person's amount of PA from childhood on throughout life. In the PAB the amount of sport activities (endurance with low intensity, medium intensity, and high intensity; sports with high impact of speed and/or strength) and locomotion by bike or by foot (transport) are assessed. In order to make clear what is meant by low, moderate and high intensity, the information given in Table 2 was provided for the participants. The questions are related to different time domains (previous three years, previous three weeks and during one's childhood/youth, between the age of 20 and 40 years, between the age of 40 and 60 years and above the age of 60 years). The participants are asked to answer the questions on a 5-point rating scale (0 - 4), at which the graduation indicates the amount of hours a certain type of activity has been performed per week (Table 3).

**Table 2. Description of the PA categories of the PAB.**

| | |
|---|---|
| **Endurance sports** | |
| **Low intensity** | Slight increase in breathing frequency, talking is possible |
| **Moderate intensity** | Medium increase in breathing frequency; sweating; talking is aggravated |
| **High intensity** | Large increase in breathing frequency, profuse sweating, talking is hardly possible |
| **Examples** | All endurance sports like long distance running, swimming, cycling, cross country skiing, hiking in mountainous areas, fast walking etc. |
| **Sports with high speed and/or strength demands** | |
| **Description** | Some sports demand not just endurance, but also speed and/or strength |
| **Examples** | Ball games like football, volleyball, basketball, tennis; or wrestling, judo, resistance training, field events like sprinting, jumping, throwing etc. |

### Study design

The PAB was evaluated by analyzing normal distribution, item difficulty, retest-reliability of one month, and factor analysis. There is a strong relationship between PA and physical fitness (Blair et al., 2001), in particular between current fitness and recent physical activity, and therefore construct validity was tested by means of a correlation analysis between the item responses in the PAB and the results of physical fitness tests and, in addition, with another questionnaire (FFB-mot) testing self-assessed fitness.

### Participants

The PAB was evaluated by testing three different samples (altogether 141 participants). The characteristics of these samples are depicted in Table 4 in which also the applied quality criteria tests are indicated. Sample A consisted of 33 healthy men and 22 healthy women (59 people were tested, 4 very old ones were excluded because of a large age gap to all others). The participants have not been participating in any sports competitions at a higher level and also were not currently studying exercise science or physical education. They received a free folder including all of their test results and an individual rating of their physical fitness status. Sample B consisted of exercise science or physical education students and sample C were budding students, who just passed the entry tests for the exercise science or physical education program at the local University.

### Measures

*Questionnaires:* Three questionnaires were used in this study. One questionnaire included questions concerning demographical data and medical history. The second one was the new self-assessment questionnaire PAB (Physical

**Table 3. Items of the PAB.**

| beginning of the items | type of activity | time frame |
|---|---|---|
| How many hours per week on average have you been | …endurance with low intensity… | …during the previous 3 years? |
| doing… | …endurance with medium intensity… | ...during the previous 3 weeks? |
| | …endurance with high intensity … | ...during your youth? |
| | …sports with high impact of speed and/or strength … | …between the age of 20 and 40 years? |
| | …locomotion by bike or foot… | …between the age of 40 and 60 years? |
| | | …above 60 years? |

*Note:* The beginning of the items was always the same, the type of activity and the time frame varied; Items were answered using a 5-point rating scale 0… 0 hours; 1…1 hour; 2… 2 hours; 3… 3 hours; 4… 4 hours or more.

Activity Biography). The third questionnaire, the Physical Fitness Questionnaire (Bös et al., 2002) (Fragebogen zur Erfassung des motorischen Funktionszustandes, FFB-Mot) deals with current physical fitness and contains 24 items and 4 scales: Strength, Endurance, Flexibility, and Coordination. The participants were asked how problematic conducting a certain PA would be for them. The rating scale ranges from 1 (*I cannot do this activity)* to 5 (*I have no problems)*.

*Exercise tests:* In addition to the FFB-Mot questionnaire, physical fitness was also assessed by means of exercise tests in sample A:

Endurance was tested on a cycle ergometer using a stepwise increase of load every minute according to Hofmann and Tschakert (2011) in which heart rate, ECG, lactate, and spirometric data and Lactate Turn Points 1 and 2 were determined. For the analysis of construct validity, obtained values (in respect of body weight) for $VO_{2max}$ ($VO_{2max,rel}$) and for maximum power ($P_{max,rel}$) were used.

Flexibility of the muscle groups: m. erector spinae, m. rectus femoris, m. trapecius, m. triceps surae, m. pectoralis, mm. adductores, mm. ischiocruales, m. iliopsoas were tested using standard flexibility tests (modified from Janda, 1979, 1994). Both sides were tested separately and a three- point rating scale (1… far beneath normal range; 2… beneath normal range; 3…within normal range) was used. The scores of the eight muscle groups and the two sides were summed up, thus the flexibility scores ranged from 16 to 48. A higher score indicates a better flexibility.

Balance was determined using four simple tests. The participants were asked to stand still in certain positions for at least 10 seconds. While standing in those positions they were not allowed to jump or move their foot or feet. Prior to every exercise, the participants had one minute to practice each task. Every exercise was tested first with both feet and then with the right foot and finally with the left foot. The exercises were: standing with open eyes; standing with closed eyes; standing on one's tiptoe(s) with open eyes, and standing on one's tiptoe(s) with closed eyes. They could try to complete each task in two attempts. For every task that could be successfully completed, the participants got one point. Zero to 12 points could be reached.

Speed was assessed using the Sprint Power Test (Müller and Fürhapter-Rieger, 2006; Müller and Schmölzer, 2006). This test was designed to quantify the maximum short- time muscle power. A mechanical weight ergometer (Monark 874E weight) and an electronic devise (Power Analyser) for measuring the velocity of the flywheel and thus the power output were used. The participants did a sprint power test at a four % (of their body weight) load (Müller and Fürhapter-Rieger, 2006; Müller and Schmölzer, 2006). The test took only a few seconds.

For strength, three different tests were used: Strength of the hands was assessed using a pinch strength dynamometer. Both hands were tested in a sitting position with the elbow of the tested arm on a desk. The elbow angle was 90°, two attempts were allowed. The mean values of the best results of each hand divided by body weight were used. Arm strength was tested by measuring remaining weight (on a Kistler ground reaction force plate) when the person tried to lift the body by pulling up with one arm (elbow was in rectangular position). The differences of body weight and remaining weight on the plate divided by body mass [N $kg^{-1}$] was used. The participants had one attempt per arm and both arms were

**Table 4. Characteristics of the tested samples.**

| | Characteristics | | | | | | | | | | Quality crit. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | lifestyle | | | IA | R | V | |
| sample | N | sex | | age | | BMI | | physical health* | | psychological health* | | | Q | ET |
| | | m | f | M (SD) | Range | M (SD) | Range | M (SD) | Range | M (SD) | Range | | | | |
| **A: normal population** | 55 | 33 | 22 | 34.6 (11.7) | 18-56 | 23.7 (3.4) | 18.1-33.7 | 1.55 (.50) | 1-2 | 1.44 (.57) | 1-3 | X | X | X | X |
| **B: exercise science stud.** | 26 | 19 | 7 | 22.5 (2.4) | 19-28 | 18.9 (2.8) | 18.9-30.1 | 1.50 (.51) | 1-2 | 1.54 (.58) | 1-3 | X | X | X | |
| **C: exercise science stud. (1st semester)** | 60 | 40 | 20 | 20.9 (3.6) | 18-38 | 22 (1.9) | 18.4-28.4 | 1.26 (.44) | 1-2 | 1.21 (.46) | 1-3 | X | | X | |

*Abbreviations:* N: sample size; m: male, f: female; M: mean; SD: standard deviation; BMI: body mass index; IA: item analysis; R: retest-reliability; V: validity; Q: questionnaire; ET: exercise tests; X: analysed; * assessed by rating scale (1…very good; 4… bad).

tested. Jumping power was tested by doing squat jumps on the Kistler force plate (Müller and Schmölzer, 2006). The participants had three attempts to reach their maximal jumping height.

### Testing

The experimental protocol was approved by the ethics committee of the local Medical University. The participants were informed about the study and asked to sign an informed consent before they answered the three questionnaires (demographical questionnaire, PAB and FFB-Mot). Additionally, the actual physical fitness status (in terms of endurance, speed, strength, balance, and flexibility) was assessed in sample A. The order of the exercise tests was: endurance, flexibility, balance, speed, and strength. Between the tests there was enough time for the participants to recover from the previous test. To determine the retest-reliability of the questionnaire, the participants were asked to answer the PAB again when they got their test results one month after the tests. Within one month 34 of all 55 participants (61.8%) participated in the retest. Participants of sample B were also asked to answer the PAB for one more time after one month. At this second testing time, 16 of the 26 students (61.5%) participated. The participants of sample C were only tested once and answered all three questionnaires.

### Statistical analyses

The data was analyzed using the Statistical Package for the Social Sciences (SPSS; version 16; SPSS Inc., Chicago, IL, USA). The probability for a Type I error was 0.05 for all tests. Means and standard deviations (SD) were obtained for the items. The mean value of an item can also be used as an indicator for item difficulty. Item difficulty should be at a moderate level to warrant good differentiation between the participants (Lienert and Raatz, 1998). Further, the shape of the distribution of the answers was investigated by analysing skewness and kurtosis. Item difficulty of all items concerning sport was expected to be higher for sample A compared to sample B and C who consisted of exercise science and physical education students. Quality criteria for the items were examined: retest-reliability of the single items was analyzed. In this study a retest interval of one month was chosen in order to meet the demands that the time interval between the test and retest is short enough to ensure that participants had not changed their PA levels, but long enough to prevent recall (van Poppel et al., 2010). For determining retest-reliability, the Intraclass Correlation Coefficient (ICC) was used in this study, because it does not overestimates reliability by ignoring systematic differences between the two measurements like e.g. the Pearson Correlation Coefficient (Terwee et al., 2010). A value higher than 0.7 was considered as good (Terwee et al., 2010). For determining validity, items obtained with sample A were correlated (Spearman-Rho) with the results of the exercise tests and also with the scales of the FFB-Mot. Only those items were validated that asked about the person's late past (previous three weeks, previous three years). Using a Multitrait-Multimethod-Matrix the criteria of convergent and discriminant validity were investigated (Campbell and Fiske, 1959). There are no guidelines on how high the correlation coefficients indicating validity of PA assessment questionnaires should be(Terwee et al., 2010). As validity is always lower than reliability, which should be over 0.7, and because of the questionnaire complexity which results from the aim to assess various types of PA, a correlation coefficient of 0.4 and higher was chosen to be sufficient for validity (van Poppel et al., 2010). Factor analysis (Principal Component Analysis, orthogonal rotation) was used in order to detect possible factors. The number of factors was determined using the Kaiser criterion, (Eigenvalues of all factors larger than 1). Additionally, a graphical examination of the scree plot was carried out. As not all participants could answer all items (because they were not old enough) a pair-wise exclusion of missing values was chosen. Only 23 persons could answer questions which deal with PA at the age of 40 years and older. Therefore, only items of the time frames previous three years, previous three weeks, youth, and between 20 and 40 years (=20 items) were included. A Bartlett Test of Sphericity was conducted to test whether the correlation matrix corresponded to the identity matrix.

## Results

### Item analysis

Item difficulty can be classified as moderate for sample A, whereas for sample B and C the difficulties were lower, indicated by higher mean values (Table 5). Items assessing the amount of endurance with high intensity in most cases had higher difficulties than the other items. Sports with high speed and/or strength demands had high difficulties for sample A and in comparison lower difficulties for sample B and C. Additionally; it was observed that the difficulties of the items increase with the people's age in the time frames. Apart from two items in sample A (transport during the previous three years: $z_{kurtosis}$= -2.09; $p < 0.05$; sports with high speed and/or strength demand during the previous three weeks $z_{skewness}$= 2.67; $p < 0.01$), normal distribution analysed by skewness and kurtosis was given for all items and samples.

### Reliability

The reliability of the questionnaire was analysed by means of retest-reliability (Table 6). The same group of people answered the questionnaire two times with a time interval of one month between the two testing times. An ICC higher than 0.7 was given for most items. Items which did not meet this criterion were items assessing endurance with low or medium intensity. Sample B achieved lower ICC's than sample A.

### Validity

Correlations (Spearman's-Rho) between the items and the validity criteria were calculated (Table 7).

Correlations with exercise test results higher than 0.4 were found in the following items: Endurance with high intensity during the previous three years and $P_{max,rel}$, endurance with high intensity during the previous three weeks and $P_{max,rel}$, sports with high speed and/or strength

**Table 5.** Item difficulties.

| | | Sample A | | Sample B | | Sample C | |
|---|---|---|---|---|---|---|---|
| **time frame** | **type of activity** | **N** | **item difficulty** | **N** | **item difficulty** | **N** | **item difficulty** |
| **previous 3 weeks** | **end with low I** | 55 | 1.87 | 25 | 2.6 | 5 | 1.9 |
| | **end with mod I** | 55 | 2.18 | 26 | 2.19 | 58 | 2.41 |
| | **end with high I** | 51 | 1.31 | 24 | 1.75 | 58 | 2.21 |
| | **speed/strength** | 52 | 1.25 | 25 | 2.4 | 58 | 2.69 |
| | **transport** | 54 | 1.87 | 25 | 2.24 | 58 | 2.6 |
| **previous 3 years** | **end with low I** | 54 | 1.98 | 25 | 2.44 | 60 | 2.33 |
| | **end with mod I** | 55 | 2.00 | 26 | 2.46 | 60 | 2.47 |
| | **end with high I** | 53 | 1.02 | 24 | 1.96 | 60 | 2.28 |
| | **speed/strength** | 54 | 1.41 | 25 | 2.76 | 60 | 3.07 |
| | **transport** | 55 | 2.13 | 26 | 2.27 | 60 | 2.65 |
| **between 40 & 60 years** | **end with low I** | 24 | 1.62 | | | | |
| | **end with mod I** | 24 | 1.92 | | | | |
| | **end with high I** | 23 | 1.09 | | | | |
| | **speed/strength** | 23 | 1.13 | | | | |
| | **transport** | 22 | 1.50 | | | | |
| **between 20 & 40 years** | **end with low I** | 49 | 1.98 | 24 | 2.5 | 25 | 2.28 |
| | **end with mod I** | 49 | 2.16 | 25 | 2.4 | 25 | 2.44 |
| | **end with high I** | 48 | 1.12 | 24 | 2 | 25 | 2.28 |
| | **speed/strength** | 49 | 1.35 | 24 | 2.46 | 25 | 2.96 |
| | **transport** | 49 | 2.04 | 24 | 2.25 | 25 | 2.68 |
| **youth** | **end with low I** | 55 | 1.96 | 25 | 2.44 | 59 | 2.49 |
| | **end with mod I** | 55 | 2.24 | 26 | 2.31 | 58 | 2.41 |
| | **end with high I** | 53 | 1.32 | 25 | 2.04 | 58 | 2 |
| | **speed/strength** | 53 | 1.72 | 25 | 2.68 | 59 | 2.78 |
| | **transport** | 55 | 2.20 | 25 | 2.44 | 59 | 2.63 |

*Abbreviations:* I: intensity; mod: moderate; end: endurance.

impact during the previous three years and $VO_{2max,rel}$. The latter correlation was not expected.

Between the PAB and the FFB-Mot there were a couple of expected correlations larger than 0.4: Between the FFB-Mot endurance scale and endurance with medium intensity during the previous three years, endurance with high intensity during the previous three years, and endurance with high intensity during the previous three weeks. Between the strength scale of the FFB-Mot and sports with high speed and/or strength impact during the previous three weeks and previous three years, and the coordination scale of the FFB-Mot and sports with high speed and/or strength impact during the previous three weeks.

Also some correlations higher than 0.4 were found which were not expected: Sports with high speed and/or strength impact during the previous three weeks and previous three years and the endurance scale.

Convergent and discriminant validity of items concerning the previous three years: Concerning convergent validity of the endurance questions, items dealing with endurance with medium and high intensity during the previous three years showed significant correlation coefficients with the tested $VO_{2max,rel}$ and $P_{max\ rel}$ and the endurance scale of the FFB-mot. There were also significant correlations found with hand strength (with endurance with high intensity; $r_{52} = 0.29$; $p < 0.05$) and the strength scale of the FFB-mot (with endurance with moderate intensity; $r_{54} = 0.31$; $p < 0.05$; with endurance with high intensity; $r_{54} = 0.28$; $p < 0.05$). However, these correlation coefficients were lower than the expected ones. Endurance with low intensity during the previous three years correlated significantly only with the endurance scale of the FFB-mot ($r_{54} = 0.27$; $p < 0.05$).

Sports with high speed and/or strength impact during the previous three years correlated significantly with related exercise tests namely hand strength, arm strength, speed, and jumping height. However, there were also significant coefficients with the tested endurance parameters. These coefficients were by trend even higher than the coefficients with related constructs. Additionally, this item correlated significantly with all scales of the FFB-mot, whereas the correlation with the strength scale was

**Table 6.** Intraclass Correlation Coefficients.

| | 3 weeks | | 3 years | | 40-60 y | | 20-40 y | | youth | |
|---|---|---|---|---|---|---|---|---|---|---|
| **sample** | **A** | **B** | **A** | **B** | **A** | **B** | **A** | **B** | **A** | **B** |
| **N** | **32-34** | **15-16** | **29-33** | **14-15** | **14-15** | **0** | **29-31** | **14** | **30-33** | **15** |
| **end low I** | .81† | .55+ | .82† | .23 | .78† | - | .65† | .62 | .60† | .55 |
| **end medium I** | .61† | .38 | .60† | .38 | .93† | - | .67† | .62 | .64† | .80† |
| **end high I** | .86† | .86† | .80† | .87† | .92† | - | .76† | .82† | .84† | .89† |
| **speed/strength** | .93† | .74† | .72† | .81† | .96† | - | .84† | .77† | .81† | .86† |
| **transport** | .88† | .87† | .88† | .81† | .79† | - | .78† | .93† | .78† | .94† |

*Abbreviations:* end: endurance; I: intensity; N: sample size; sample A: healthy population; sample B: physical education students, y: years. * $p < 0.05$, † $p < 0.01$.

**Table 7. Convergent and discriminant validity of sample A.**

| | | exercise tests | | | | | | | | FFB-Mot | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PAB | endurance | | strength | | flex | bal | sp | jh | end | str | flex | coo |
| | | $VO_{2max,rel}$ | $P_{max,rel}$ | hand | arm | | | $v_{max}$ | | | | | |
| 3 weeks | end low I | .13 | .21 | .25 | .12 | -.01 | -.11 | .11 | -.02 | .20 | .08 | .23 | .25 |
| | end mod I | .28* | .25 | .01 | .11 | -.12 | -.15 | .17 | .01 | .37† | .30* | .24 | .18 |
| | end high I | .38† | .51† | .24 | .05 | .02 | .15 | .18 | .24 | .65† | .3† | .29* | .36* |
| | speed/str | .35* | .31* | .25* | .16 | -.06 | -.07 | .17 | .35* | .41† | .51† | .32* | .41† |
| | transport | -.08 | -.08 | .23 | .08 | .02 | -.17 | .01 | .08 | -.04 | .09 | .17 | .16 |
| 3 years | end low I | .12 | .21 | .15 | .15 | .07 | .04 | .19 | .11 | .27* | .10 | .08 | .18 |
| | end mod I | .30* | .35† | -.02 | .11 | -.13 | .11 | .15 | .16 | .44† | .31* | .23 | .15 |
| | end high I | .30* | .47† | .29* | .27 | -.01 | .10 | .15 | .09 | .62* | .28* | .24 | .24 |
| | speed/str | .40† | .36† | .36† | .32* | -.02 | -.01 | .29* | .36† | .47† | .54† | .33* | .39† |
| | transport | -.13 | -.04 | .08 | -.09 | -.06 | .04 | -.15 | -.17 | .06 | .06 | .16 | .12 |

*Abbreviations:* I: intensity; end: endurance; mod: moderate; str: strength; flex: flexibility; bal: balance; sp: speed with load of 4% of the body weight; jh: jumping height; coo: coordination. *Note:* * $p < 0.05$; † $p < 0.01$.

the highest ($r_{54} = 0.54$; $p < 0.01$).

Convergent and discriminant validity of items concerning the previous three weeks: Endurance with low intensity during the previous three weeks showed neither significant correlations with the exercise tests, nor with the scales of the FFB-mot. Endurance with medium intensity during the previous three weeks correlated significantly with $VO_{2max,rel}$ ($r_{54} = 0.28$; $p < 0.05$) and with the endurance scale of the FFB-mot as well ($r_{54} = 0.37$; $p < 0.01$), no significant correlation was found with $P_{max\ rel}$ ($r_{54} = 0.25$; ns.), but with the strength scale of the FFB-mot ($r_{54} = 0.30$; $p < 0.05$). Endurance with high intensity during the previous three weeks correlated significantly with the endurance parameters of the exercise tests and the endurance scale of the FFB-mot; there were also significant correlations with the other scales of the FFB-mot: strength, coordination, and flexibility.

The item asking about sports with high speed and/or strength impact during the previous three weeks was only significantly related to hand strength and jumping high. There was no significant correlation with arm strength and speed, but significant correlations with the endurance parameters of the spirometric test. The items correlated with all four scales of the FFB-mot. Also, for this item the correlation with the strength scale was the highest. ($r_{54} = 0.51$; $p < 0.01$).

Concerning transport during the previous three years and the previous three weeks there was no significant relationship with any of the validity criteria.

Summing up: Most of the items of the questionnaire were moderately correlated with exercise tests and scales of the FFB-Mot that measure similar constructs (convergent validity) and showed lower correlations with constructs that should not be related to them (discriminant validity). Therefore, the criteria of convergent and discriminant validity were fulfilled.

## Factor analyses

In order to find out whether the different types of PA during different time frames assessed by the PAB could be found as independent factors, a factor analysis was conducted. The Bartlett Test of Sphericity was significant which means that the given correlation matrix differed significantly from the identity matrix ($\chi^2_{190} = 1479.36$; $p < 0.01$). The factorial analysis found four factors with Eigenvalues larger than 1 (Kaiser Criterion). The scree plot also justified retaining four components. 71.6% of all variance could be explained by the four factors. Table 8 shows the factor loadings after the Varimax rotation. The items that clustered on the same factors suggest that component one represents lifetime endurance with vigorous intensity, component two lifetime PA during transport, component three lifetime sports with high speed and/or strength impact and component four lifetime endurance with low intensity. All different types of PA that have been assessed loaded on independent factors, except for endurance with medium intensity and endurance with high intensity; these two PA categories loaded on the same factor. The internal consistency of the scales with values between 0.84 and 0.90 can be considered as good.

## Discussion

Item difficulty of sample A was moderate and slightly higher than for samples B and C, which was to be expected because sample B and C consisted of physical education students, who were trained on a higher level than the participants in sample A. It was found that items assessing endurance with high intensity showed higher item difficulty for most items (i.e. a low average amount of PA time per week was stated) than those asking about endurance with low or moderate intensity. Training sessions with high intensity are more demanding than sessions with lower intensity and people need more time for recreation. They are rather conducted by athletes and individuals following special training goals. According to Sjöström and colleagues (2002), adults spend more time on moderate intensity PA (including walking) compared to vigorous PA. The items concerning sports with high speed and/or strength demands showed rather high difficulties in sample A and rather low difficulties in samples B and C. This might be due to the fact that many exercise science or physical education students were currently or have been participating in such sports (like volleyball, handball, basketball, soccer, tennis, badminton etc.) in a club or team; this was stated by them in the demographical questionnaire (currently participating: sample B: 10 out of 26; sample C: 26 out of 60; have been playing in the past: sample B: 14 out of 26; sample C: 29 out of 60). Normal distribution was given for all items and samples (except for two items in sample A).

**Table 8. Communalities ($h^2$) and factor loadings of the rotated principal components (N = 141).**

| time frame | PA | | components | | | |
|---|---|---|---|---|---|---|
| | | $h^2$ | 1 | 2 | 3 | 4 |
| previous 3 weeks | end low I | .66 | .25 | .2 | -.02 | .74 |
| | end mod I | .65 | .67 | .14 | -.12 | .40 |
| | end high I | .71 | .81 | .04 | .25 | .03 |
| | speed/strength | .80 | .20 | .02 | .87 | -.01 |
| | transport | .74 | .09 | .82 | .18 | .19 |
| previous 3 years | end low I | .80 | .18 | .13 | .03 | .87 |
| | end mod I | .71 | .74 | .01 | -.01 | .41 |
| | end high I | .68 | .76 | .06 | .29 | .13 |
| | speed/strength | .84 | .17 | .07 | .90 | .03 |
| | transport | .76 | .11 | .84 | .08 | .21 |
| 20-40 years | end low I | .84 | .16 | .15 | .01 | .89 |
| | end mod I | .72 | .70 | .15 | -.03 | .45 |
| | end high I | .82 | .87 | .03 | .25 | .09 |
| | speed/strength | .87 | .20 | .22 | .88 | -.04 |
| | transport | .83 | .05 | .88 | .16 | .18 |
| youth | end low I | .52 | .22 | .41 | .09 | .54 |
| | end mod I | .55 | .55 | .42 | -.08 | .27 |
| | end high I | .55 | .63 | .35 | .17 | .02 |
| | speed/strength | .64 | -.03 | .08 | .79 | .03 |
| | transport | .64 | .14 | .79 | -.01 | .05 |
| | eigenvalue | | 7.24 | 3.15 | 2.52 | 1.41 |
| | % of variance | | 22.40 | 17.10 | 16.49 | 15.65 |
| | α | | .90 | .89 | .90 | .84 |

*Abbreviation:* PA: physical activity; I: intensity; end: endurance; mod: moderate α: internal consistency.

Retest-reliability was satisfying (ICC ≥ 0.7) for most items. However, there were rather low ICC values for items dealing with endurance with low or medium intensity. It was probably difficult for the participants to distinguish between endurance with low intensity and endurance with medium intensity. This is not surprising because endurance with low and endurance with medium intensity merge and there is no strict borderline between them. Further, the description of intensity regimes is not a part of everyday's conversation in the population, and the accuracy of verbal descriptions of intensity levels is limited. The ability of the participants to distinguish between these intensity levels may be increased by giving more examples, rather than descriptions. The effect that sample B achieved lower ICC's than sample A can be explained by the higher homogeneity of the participants concerning sports and PA and the lower sample size.

Demonstrating adequate validity criteria is very challenging when creating PA questionnaires. Especially for those questionnaires dealing with lifetime PA, this was only possible with complex and time-consuming longitudinal studies over decades. In this study, construct validity was determined by comparing the results of the PAB with actual physical fitness assessed by exercise tests and a physical fitness questionnaire. Based on numerous controlled exercise training studies, Blair (1993) stated that there is a strong relationship between PA and physical fitness: *"Physical activity and physical fitness are closely related in that physical fitness is mainly, although not entirely, determined by physical activity patterns over recent weeks or months"* (Blair et al., 2001). According to Blair (1993) prospective studies on the relationship between physical fitness and mortality show higher inverse associations than studies on PA and mortality. He explained this effect by a smaller amount of misclassification when measuring physical fitness compared to PA. Physical fitness is measured with more objective methods (e.g. exercise tests), while PA is usually measured by subjective self-report methods (e.g. diary, questionnaires) (Blair et al., 2001). Summing up PA and physical fitness are closely related, whereas physical fitness can be measured more precisely. Consequently, the assessment of PA was not evaluated with another method testing PA, but with a more precise, related parameter: physical fitness. According to Forsén et al. (2010), many other studies on PA questionnaires also used some kind of physical fitness variables, namely various health or physical function variables, like chair stand, 6- minutes walking test, BMI, $VO_{2max}$ etc. as comparison instruments.

According to the Multitrait-Multimethod-procedure (Campbell and Fiske, 1959) we expected to find higher correlation values between similar types of variables assessed with different methods (convergent validity) and lower coefficients between different types of variables assessed with the same or different methods (discriminant validity). This held true for many coefficients, but not for all. The coefficients were rather low and the criterion of a correlation coefficient higher than 0.4 was not always fulfilled. Items assessing endurance with medium and high intensity were not only related to endurance performance determined by means of spirometry and the endurance scale of the FFB-mot questionnaire, but also to the strength scale of the FFB-mot, however with a lower coefficient. Sports with high speed and/or strength impact appeared to be a very broad category as it correlated not only with related criteria, like hand strength, arm strength, speed, jumping height, and the

strength and coordination scale of the FFB-mot, but also with $VO_{2max,rel}$ and $P_{max,rel}$, and all four scales of the FFB-mot. The speed/strength items correlated at the same or even a higher level with the endurance variables of the incremental cycle test when compared to the results of the strength and speed exercise tests. In this regard, it is important to mention that the effects of different types of training can be overlapping. For example, not only endurance training can improve the $VO_{2max}$, but also training for speed (Tabata et al., 1996); further, it is well-known that strength training can improve endurance performance (Hasegawa et al., 2002). The effects of a special type of PA may vary largely depending on intensity, duration, load, current fitness status, and individual characteristics: *"We are all individuals and, whereas physiological responses to particular stimuli are generally predictable, one individual's precise response and adaptation to those stimuli are largely unpredictable and will vary from those of others"* (Brooks et al., 2005). It must be considered that a special type of PA can influence many aspects of physical fitness (endurance, speed, coordination, strength etc.), in particular when persons do not start out from a high performance level. Nevertheless, there are certain PA types that influence particular dimensions of physical fitness more than others, therefore higher correlations between these variables were expected. It should be taken into account that also the genes are considered to be an important factor concerning the development of physical fitness (Bouchard et al., 1999; 2000). The results obtained may also be explained by the allocation of different types of sports to the items: the participants were told to relate ball sports like basketball, soccer etc. to sports with high speed and/or high strength impact. However, for these kinds of sports also the factor endurance is very important. For such complex sorts of sports it is very difficult to allocate them to a certain type of exercise. Nevertheless, this questionnaire aims to figure out a distinct category for strength and speed, although the assessment of this faces principal problems and limitations.

In the factor analysis four factors were found. One factor included endurance with moderate and high intensity whereas the other factors only included one type of PA each, namely endurance with low intensity, PA with high speed and/or strength impact, and transport. As the retest-reliability of the items dealing with endurance with medium intensity was low and the factorial analysis showed that both medium and high intensity endurance items loaded on the same factor, it might be reasonable to merge these two questions in a new version of the PAB into one. However, as the mean values for all time frames of the items endurance with medium intensity and endurance with high intensity were above 2 and 1, respectively, combining these variables could lead to skewness of the distribution of the ratings and lower item difficulty, which would reduce the differentiation ability of the items. Therefore, we decided to keep the present intensity graduation of the endurance items, but endurance with medium and high intensity should be combined when calculating factors.

Many recommendations about the minimum amount of PA to gain health benefits refer to the terms moderate and vigorous PA. For example, the American College of Sports Medicine (ACSM) recommends: "*To promote and maintain health, all healthy adults aged 18 to 65 yr need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 min on three days each week*" (Haskell et al., 2007). Furthermore, endurance exercise should be amended by resistance and flexibility training: *"In addition to aerobic exercise, people should engage in resistance training and flexibility exercises at least twice a week, which will promote the maintenance of lean body mass, improvements in muscular strength and endurance, and preservation of function, all of which enable long-term participation in regular physical activity and promote quality of life"* (Blair et al., 2004).

This questionnaire could help to assess the amount of these types of PA and assist individuals to find out whether they have met the recommendations or not. According to Haskell et al. (2007), the ACSM exemplifies aerobic PA with moderate intensity as brisk walking, which noticeably accelerates the heart rate. Vigorous-intensity aerobic PA can e.g. be achieved by jogging and causes rapid breathing and a substantial increase in heart rate (Haskell et al., 2007). These types of aerobic PA can be easily assessed by the PAB: The amount of leisure-time aerobic PA with moderate intensity can be tested by analyzing the items concerning endurance with low intensity and transport. The leisure-time vigorous-intensity PA can be measured with the items concerning endurance with medium and high intensity. Resistance-type training can be assessed with the items dealing with sports with high speed and/or strength demand.

As most questionnaires use the Metabolic Equivalent of Task (MET) to estimate the energy expenditure of different types of PA (Booth, 2000), the PAB should also enable its users to do so. 1 MET is equivalent to 4184 $J \cdot kg^{-1} \cdot h^{-1}$(Ainsworth et al., 2000), i.e. 1.16 $W \cdot kg^{-1}$, and this is considered as resting metabolic rate obtained during quiet sitting. We scanned through the Compendium of PA (Ainsworth et al., 2000) and listed exemplarily different types of PA and their MET values and allocated them to the different item categories of the PAB. From these lists, average METs for each type of items were deduced (Table 9). These values can be used to estimate a person's energy expenditure based on their answers in the PAB. However, it has to be pointed out that such an approach would ignore that high speed or strength training with its specific effects may have impact on prevention and treatment of diseases which cannot be expressed in terms of average energy expenditure.

**Table 9. Average METs (over training session) for the different types of items**

| Item<br>Part A | Average METs |
|---|---|
| Endurance with low intensity | 5 |
| Endurance with moderate intensity | 7 |
| Endurance with high intensity | 11 |
| Sport with high speed and/or strength impact | 9 |
| Transport | 3 |

The PAB is the only questionnaire that can assess biographical and recent physical activity with adequate reliability and validity with only two pages of questions. This is a major incremental benefit when compared to other questionnaires used today. Further, it is easy to administer, analyze and interpret the results.

The deduced information on the average amount of different types of PA during certain time frames can also be transformed into METs (Table 9). As only rating scales are provided for answering the questions, automatic processing is possible and the PAB can be used to test a large sample with low costs and efforts. Because of the PAB's shortness it can also be embedded in larger test batteries.

## Limitations

The construction of a questionnaire analyzing biographical PA is a very complex process, hence this study has several limitations: Certain trainings sessions, e.g. soccer training, can include endurance training and training for speed or strength. Thus, it is sometimes hard to allocate such training session to a certain type of PA provided in this questionnaire.

Of course, longitudinal reliable data on the amount of PA during certain lifetime frames are notoriously hard to get. Therefore, in the present study only the actual fitness status of the time of the questionnaire evaluation could be assessed.

A larger sample size for the study would empower the statistical analysis; however the number of participants could not be enlarged as desired, because of the complexity of the investigation.

The items were only tested for people aged between 18 and 56, thus, the items concerning the time frame "above 60 years" could not be evaluated yet. In a further study the PAB should be tested with a group of elderly people too. For elderly people, answering the questionnaire can be quite difficult as they have to recall how much and what kind of PA they did many decades before. Older people may have a larger recall bias than younger people when answering questions about early life time frames (Winters-Hart et al., 2004). According to Kriska and Caspersen (1997), questionnaires focusing on leisure and occupational PA are rather valid for younger and healthier populations. For older or diseased populations, questionnaires dealing with low-level leisure activities and activities of daily living (like cooking, bathing etc.) could be more accurate (LaPorte et al., 1984). Hence, the items concerning recent PA may be not suitable for such populations.

It may be useful to evaluate the PAB also with other high quality PA questionnaires (van Poppel et al., 2010), like e.g. the IPAQ (Booth, 2000), although they do not consider PA biography and also different types of PA.

The questionnaire has been presented in German and tested in a German-speaking population; a version in English exists already, however the applicability in English-speaking populations is to be tested.

## Conclusion

The questionnaire introduced here is the only questionnaire which aims to measure biographical PA and which is designed to distinguish between different types of PA. Although this is a very complex question, the results fulfilled the expectations concerning item difficulty, normal distribution, reliability and validity. The PAB can be used as a self- assessment tool to determine the amount of recreational PA and PA in the course of transport a person has accomplished. The risk of developing non-communicable diseases depends largely on the PA biography (Siscovick et al., 1985). Among these diseases are e.g. cardiovascular diseases (Blair et al., 1996), certain types of cancer (Courneya and Friedenreich, 2011), non–insulin-dependent diabetes mellitus (1994), certain bone diseases (Jaglal et al., 1993), mental disorders (Camacho et al., 1991) etc. In this context the PAB may become an important measurement tool for risk assessment.

Although the evaluation of a questionnaire dealing with such a difficult question, involves a very large effort, it appears to be warranted to further develop this questionnaire and to evaluate it with larger samples, including elderly people in order to increase the informative value.

## References


Ainsworth, B.E., Haskell, W.L., Whitt, M.C., Irwin, M.L., Swartz, A.M., Strath, S.J., O'Brien, W.L., Bassett, D.R., Schmitz, K.H., Emplaincourt, P.O., Jacobs, D.R.J. and Leon, A.S. (2000) Compendium of physical activities: An update of activity codes and MET intensities. *Medicine and Science in Sports and Exercise* **32( Suppl.)**, 498-504.

Blair, S.N. (1993) 1993 C. H. McCloy Research Lecture: Physical activity, physical fitness, and health. *Research Quarterly for Exercise and Sport* **64(4)**, 365-376.

Blair, S.N., Cheng, Y. and Holder, J.S. (2001) Is physical activity or physical fitness more important in defining health benefits? *Medicine and Science in Sports and Exercise* **33(6)**, 379-399.

Blair, S.N., Kampert, J.B., Kohl, H.W., 3rd, Barlow, C.E., Macera, C.A., Paffenbarger, R.S., Jr. and Gibbons, L.W. (1996) Influences of cardiorespiratory fitness and other precursors on cardiovascular disease and all-cause mortality in men and women. *JAMA* **276(3)**, 205-210.

Blair, S.N., LaMonte, M.J. and Nichamann, M.Z. (2004) The evolution of physical activity recommendations: how much is enough? *American Journal of Clinical Nutrition* **79(5)**, 913S-920S.

Booth, M.L. (2000) Assessment of physical activity: An international perspective. *Research Quarterly for Exercise and Sport* **71(2)**, 114-120.

Bös, K., Abel, T., Niemann, S., Woll, A., Tittlbach, S. and Schott, N. (2002) Der Fragebogen zur Erfassung des motorischen Funktionsstatus (FFB-Mot). *Diagnostica* **48(2)**, 101-111. (In German).

Bouchard, C. (2001) Physical activity and health: introduction to the dose-response symposium. *Medicine and Science in Sports and Exercise* **33(6)**, S347-S350.

Bouchard, C., An, P., Rice, T., Skinner, J.S., Wilmore, J.H., Gagnon, J., Pérusse, L., Leon, A.S. and Rao, D.C. (1999) Familial aggregation of $VO_{2max}$ response to exercise training: results from the HERITAGE Family Study. *Journal of Applied Physiology* **87(3)**, 1003-1008.

Bouchard, C., Rankinen, T., Chagnon, Y.C., Rice, T., Pérusse, L., Gagnon, J., Borecki, I., An, P., Leon, A.S., Skinner, J.S., Wilmore, J.H., Province, M. and Rao, D.C. (2000) Genomic scan for maximal oxygen uptake and its response to training in the HERITAGE Family Study. *Journal of Applied Physiology* **88(2)**, 551-559.

Brooks, G.A., Fahey, T.D. and Baldwin, K.M. (2005) Introduction: The Limits of Human Performance. In: *Exercise physiology: Human bioenergetics and its applications*. Eds: Brooks, G.A., Fahey, T.D. and Baldwin, K.M. 4th edition. New York: McGraw-Hill. 1-18.

Camacho, T.C., Roberts, R.E., Lazarus, N.B., Kaplan, G.A. and Cohen, R.D. (1991) Physical activity and depression: evidence from the Alameda County Study. *American Journal of Epidemiology and Community Health* **134(2)**, 220-231.

Campbell, D.T. and Fiske, D.W. (1959) Convergent and discriminant validation by the multitrait multimethod matrix. *Psychological Bulletin* **56**, 81-105.

Caspersen, C.J., Powell, K.E. and Christenson, G.M. (1985) Physical activity, exercise and physical fitness: definitions and distinctions for health related research. *Public Health Reports* **100**, 126-131.

Chasan-Taber, L., Erickson, J.B., McBride, J.W., Nasca, P.C., Chasan-Taber, S. and Freedson, P.S. (2002) Reproducibility of a self-administered lifetime physical activity questionnaire among female college alumnae. *American Journal of Epidemiology* **155(3)**, 282-289.

Courneya, K.S. and Friedenreich, C. (2011) *Physical activity and cancer*. Springer, Heidelberg.

Cumming, R. and Klineberg, A. (1994) A study of the reproducibility of long-term recall in elderly. *Epidemiology* **5**, 116-119.

Doyle, C., Kushi, L.H., Byers, T., Courneya, K.S., Demark-Wahnefried, W., Grant, B., McTiernan, A., Rock, C.L., Thompson, C., Gansler, T. and Andrews, K.S. (2006) Nutrition and physical activity during and after cancer treatment: An American Cancer Society guide for informed choices. *CA: A Cancer Journal for Clinicians* **56(6)**, 323-353.

Forsén, L., Loland, N.W., Vuillemin, A., Chinapaw, M.J.M., van Poppel, M.N.M., Mokkink, L.B., van Mechelen, W. and Terwee, C.B. (2010) Self-administered physical activity questionnaires for the elderly: A systematic review of measurement properties *Sports Medicine* **40(7)**, 601-623.

Frey, I., Berg, A., Grathwohl, D. and Keul, J. (1999) Freiburger Fragebogen zur körperlichen Aktivität- Entwicklung, Prüfung und Anwendung. *Sozial- und Praventivmedizin* **44**, 55-64.

Friedenreich, C.M., Courneya, K.S. and Bryant, H.E. (1998) The Lifetime Total Physical Activity Questionnaire: development and reliability. *Medicine and Science in Sports and Exercise* **30(2)**, 266-274.

Hasegawa, H., Dziados, J., Newton, R.U., Fry, A.C., Kraemer, W.J. and Häkkinen, K. (2002) Periodized training programmes for athletes. In: *Strength Training for Sport*. Eds: Kraemer, W.J. and Häkkinen, K. 1th edition. Oxford: Blackwell Science Ltd.

Haskell, W.L., Lee, I.M., Pate, R.R., Powell, K.E., Blair, S.N., Franklin, B.A., Macera, C.A., Heath, G.W., Thompson, P.D. and Baumann, A. (2007) Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise* **39(8)**, 1423-1434.

Hofmann, P. and Tschakert, G. (2011) Special needs to prescribe exercise intensity for scientific studies. *Cardiology Research and Practice* **2011**, doi: 10.4061/2011/209302. doi: 10.4061/2011/209302

Jaglal, S.B., Kreiger, N. and Darlington, G. (1993) Past and recent physical activity and risk of hip fracture. *American Journal of Epidemiology and Community Health* **138**, 107-118.

Janda, V. (1979) *Muskelfunktionsdiagnostik*. Acco, Leuven/Belgien. (In German).

Janda, V. (1994) *Manuelle Muskelfunktionsdiagnostik*. 3th edition. Ullstein Mosby, Berlin. (In German).

Kohl, H.W. (2001) Physical activity and cardiovascular disease: evidence for a dose response. *Medicine and Science in Sports and Exercise* **33(6)**, S472-S483.

Kriska, A.M., Blair, S.N. and Pereira, M.A. (1994) The potential role of physical activity in the prevention of non-insulin-dependent diabetes mellitus: the epidemiological evidence. *Exercise and Sport Sciences Reviews* **22**, 121-143.

Kriska, A.M. and Caspersen, C.J. (1997) Introduction to a collection of physical activity questionnaires. *Medicine and Science in Sports and Exercise* **29(6)**, 5-9.

Kriska, A.M., Knowler, W.C., La Porte, R.E., Drash, A.L., Wing, R.R., Blair, S.N., Bennett, P.H. and Kuller, L.H. (1990) Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care* **13**, 401-411.

Kriska, A.M., Sandler, R.B., Cauley, J.A., LaPorte, R.E., Hom, D.L. and Pambianco, G. (1988) The assessment of historical physical activity and its relation to adult bone parameters. *American Journal of Epidemiology* **127(5)**, 1053-1063.

Lagerros, Y.T. and Lagiou, P. (2007) Assessment of physical activity and energy expenditure in epidemiological research of chronic diseases. *European Journal of Epidemiology* **22(6)**, 353-362.

LaPorte, R.E., Adams, L.L., Savage, D.D., Brenes, G., Dearwater, S. and Cook, T. (1984) The spectrum of physical activity, cardiovascular disease and health: an epidemiologic perspective. *American Journal of Epidemiology* **120**, 507-517.

Lee, I.M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N. and Katzmarzyk, P.T. (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* **380(9838)**, 219-229.

Lienert, G.A. and Raatz, U. (1998) *Testaufbau und Testanalyse*. 6th edition. Psychologie Verlags Union, Weinheim.

Mäder, U., Martin, B.W., Schutz, Y. and Marti, B. (2006) Validity of four short physical activity questionnaires in middle-aged persons. *Medicine and Science in Sports and Exercise* **38(7)**, 1255-1266.

McTiernan, A. (2003) Behavioral risk factors in breast cancer: can risk be modified? *The Oncologist* **8**, 326-334.

Müller, W. and Fürhapter-Rieger, A. (2006) The Wingate test underestimates maximum power: The sprint power test measures maximum power as a function of load. *Isokinetics and Exercise Science* **14(2)**, 201-203.

Müller, W. and Schmölzer, B. (2006) The human power spectrum: Maximum physical power is a function of activity duration. *Isokinetics and Exercise Science* **14(2)**, 137-139.

Pedersen, B.K. and Saltin, B. (2006) Evidence for prescribing exercise therapy in chronic disease. *Scandinavian Journal of Medicine and Science in Sports* **16(Suppl. 1)**, 3-63.

Pereira, M.A., FitzerGerald, S.J., Gregg, E.W., Joswiak, M.L., Ryan, W.J., Suminski, R.R., Utter, C. and Zmuda, J.M. (1997) A collection of physical activity questionnaires for health-related research. *Medicine and Science in Sports and Exercise* **29**, S1-S205.

Schmitz, K.H., Courneya, K.S., Matthews, C., Denmark-Wahnefield, W., Galvão, D.A., Pinto, B.M., Irwin, M.L., Wolin, K.Y., Segal, R.J., Lucia, A., Schneider, C.M., von Gruenigen, V.E. and Schwartz, A.L. (2010) American College of Sports Medicine round table on exercise guidelines for cancer survivors. *Medicine and Science in Sports and Exercise* **47(2)**, 1409-1426.

Siscovick, D.S., La Porte, R.E. and Newman, J.M. (1985) The disease-specific benefits and risks of physical activity and exercise. *Public Health Reports* **100(2)**, 180-188.

Sjöström, M., Yngve, A., Ekelund, U., Poortvliet, E., Hurtig-Wennlöf, A., Nilsson, A., Hagströmer, M., Nylund, K. and Faskunger, J. (2002) Physical activity in groups of Swedish adults: Are the recommendations feasible? *Scandinavian Journal of Nutrition* **46(3)**, 123-130.

Tabata, I., Nishimura, K., Kouzaki, M., Hirai, Y., Ogita, F., Miyachi, M. and Yamamoto, K. (1996) Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and $VO_{2max}$ *Medicine and Science in Sports and Exercise* **28**, 1327-1330.

Terwee, C.B., Mokkink, L.B., van Poppel, M.N.M., Chinapaw, M.J.M., van Mechelen, W. and de Vet, H.C.W. (2010) Qualitative attributes and measurement properties of physical activity questionnaires: The QAPAQ checklist. *Sports Medicine* **40(7)**, 525-537.

van Poppel, M.N.M., Chinapaw, M.J.M., Mokkink, L.B., van Mechelen, W. and Terwee, C.B. (2010) Physical activity questionnaires for adults: A systematic review of measurement properties. *Sports Medicine* **40(7)**, 565-600.

Wannamethee, S.G. and Shaper, A.G. (2002) Physical activity and cardiovascular disease. *Seminars in Vascular Medicine* **2(3)**, 257-265.

Wen, C.P., Wai, J.M., Tsai, Y.C., Cheng, T.Y.D., Lee, M.-C., Chang, H.T., Tsao, C.K., Tsai, S.P. and Wu, X. (2011) Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. *Lancet* **378**, 1244-1253.

Winters-Hart, C.S., Brach, J.S., Storti, K.L., Trauth, J.M. and Kriska, A.M. (2004) Validity of a questionnaire to assess historical physical activity in older women. *Medicine and Science in Sports and Exercise* **36(12)**, 2082-2087.

Wolin, K.Y. and Tuchman, H. (2011) Physical activity and gastrointestinal cancer prevention. In: *Physical activity and cancer*. Eds: Courneya, K.S. and Friedenreich, C.M. edition. Berlin Heidel-

berg: Springer. 73-100.

## Key points

- The risk of chronic diseases depends largely on physical activity biography.
- A new questionnaire (PAB) assessing recent and lifetime physical activity was created.
- The PAB assesses physical activity during sports and transport.
- The results of the evaluation of the PAB fulfilled the expectations.
- The PAB enables to determine a person's amount of recreational physical activity.

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**Wolfram MÜLLER**
**Employment**
Institute of Biophysics, Medical University of Graz, Austria
**Degree**
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**Research interests**
Biophysics, Medical Physics, Body Composition and Anthropometry, Sports Medicine, Exercise Physiology

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