Description and profile of the journal

Antropomotoryka. Journal of Kinesiology and Exercise Sciences (JKES) is the official, reviewed, quarterly academic publication of the International Association of Sport Kinesiology (IASK), issued by the University of Physical Education in Krakow since 1989, and from 2010, in cooperation with the University School of Physical Education in Wroclaw. The journal has received academic patronage from the Rehabilitation, Physical Education and Social Integration Committee of the Polish Academy of Sciences and can be found in the IC Journal Master List international indexing database. Since 2014, the journal is published in the original electronic version in English. On subscribers’ request, the journal may be issued in English and Polish in book format.

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Aim

In Antropomotoryka. Journal of Kinesiology and Exercise Sciences (JKES) the results of innovative experiments and observations on human locomotive activities conducted under natural and laboratory conditions by researchers of human motor skills (anthropomotorsics) or related fields and disciplines, such as: physiology, psychology, physical anthropology, biomechanics, medicine, computer sciences, economics, genetics, pedagogy, sports education are presented. This allows to acquaint oneself with the essence of human physical activities, their structure, skills, motor functions and aptitudes, learning of these motor functions, their monitoring and control, and the health and sports effects of the broadly understood human notion of physical activity.

In accordance with the aim of the journal, the subject of the article should fall under one of the four thematic categories:

I. Theoretical and applied aspects of kinesiology (Fundamental and Applied Kinesiology).
II. Scientific basis of motor function training in sports and recreation (Sport Sciences).
III. Teaching, controlling and monitoring motor functions. Scientific basis, formation and evaluation of activity and physical fitness (Exercise Sciences).
IV. Reviews, debates and discussions, historical elaborations, conference announcements, reports from conferences and congresses of the IASK and brief summaries of papers printed in foreign journals, book reviews on the theory of human motor skills and also, assessment of the current state and prospects for the development in anthropomotoric research achievements (Varia).

Papers of high scientific value previously qualified for publication in another foreign journal may also be submitted, provided that the author obtains written consent to reprint the article from the foreign journal in which the text has been or will be published.

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Manuscript registration takes place in accordance with the instructions for authors: http://970.indexcopernicus.com/ibc_publishers_panel_instrukcja_obsługi_dla_autorow.pdf

- Once registered on the IC Publishers Platform, authors should contact the editorial office via the IC Publishers Panel e-mail or the editorial office directly via e-mail: antropomotoryka@awf.krakow.pl.
- The author responsible for correspondence with the publisher concerning the article receives notification confirming submission of the article, and information about stages of its publication.
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Texts submitted for publication should be written in English or Polish in accordance with the following editorial requirements:

- The volume of empirical work including the summary, figures and tables should not exceed 22 pages, and the reviews – 30 pages standard A4 size (up to 1,800 characters including spaces per page);
Texts should be prepared using only Microsoft Office Word text editor, pages should be numbered, font: Times New Roman; size: 12 points; spacing: 1.5; justified text; title written in bold typeface; centred.

Tables and figures labelled using Arabic numerals and headers, explanations and descriptions of illustrations below the figures and the results above the tables should be placed on separate pages in the English and Polish versions. Headers, explanations and descriptions below the figures and above the tables should be in English and Polish.

Example:

Table 1., Ryc. 1., Objasnienia, Chlópce

Figures and tables should be placed on separate pages (See: Illustrative material);

Title page (English and Polish versions on separate pages – if article is meant for publication in both English and Polish) containing the full title of the paper and its short title (up to 40 characters including spaces) to be placed in the running head, names of author(s), affiliation of the author(s) presented according to the following scheme: faculty, university, country, contribution of the co-authors in the creation of the article using symbols in the case of collective works (pattern of symbols according to the instructions in IC Publishers Panel); mailing address of the lead author (author’s full name, address, e-mail address and phone number).

Abstract and key words (English and Polish versions on separate pages – if article is meant for publication in both English and Polish), taking the following structure into account:

Full title of the work. Summary about 250 words with division into parts: (in English) Purpose. Basic procedures. Main findings. Conclusions (in Polish: Cel pracy. Materiały i metody. Wyniki, Wnioski), keywords containing from 3 to 15 words (preferably using the MeSH dictionary);

The main body of the text (in English and Polish)

The main body of the text should include the following parts:

Introduction. Introduction acquaints the reader with the subject of the article and places it against the background of existing research (literature review).

At the end of the introduction, the aim, research problems and hypotheses should be clearly stated.

Material and methods. An accurate description of the research subject (material) should be presented in the methodological part. The number of subjects, their age, sex and other characteristics of the participants should be indicated. Additionally, information regarding the conditions of testing, time and methods, techniques and research instruments, with particular emphasis on the description of the used apparatus should be given. The name and address of its producer should be given. If an original method or technique of research was used, it should be described precisely by presenting its validity and reliability (reproducibility). In the case of modifying already recognized methods, the applied changes must be described and the need for these changes must be justified. Statistical methods should be explained so that it can be easily determined whether they are properly suited for the purpose of research. The author of the review or meta-analysis should provide methods of searching for materials, methods of selection, etc.

Results. Presentation of the results should be logical and cohesive, and closely linked to the data in the tables and figures. Referencing results presented in the tables or figures, the abbreviated name of the table and figures (Table 1, Fig. 2) should be placed in parentheses and on the margins of the work, suggesting their location in the comments. In the main body of the paper, the same results in tables and figures cannot be repeated.

Discussion. The author should relate the results to data from literature (other than described in the introduction), highlighting the innovative and significant aspects of his/her work. The adopted hypotheses should be verified or falsified.

Conclusions. Presenting cognitive and applicative findings, the posed hypotheses should be considered and vague statements not supported by the results of the research should be avoided.

Acknowledgements. A list of persons or institution(s) contributing to the preparation of the article, financially or technically supporting the research process or article publication may be given. It is particularly desirable to provide the study grant number.

References. The bibliographic list contains only items which are referenced in the body of the text. Bibliographic descriptions, enumerated using Arabic numerals and listed in the order of citation (not in alphabetical order) should be printed on a separate page. Each referenced item should start with a new line. The sequenced number of the bibliographical item, given in square brackets, must correspond to the order of reference to the publication in the body of the text.

Bibliographic description of the article should include: the name of the author(s), initial(s), surname(s), title of the article, name of the journal in functioning abbreviated form, year of publication, issue, volume number, pages, DOI number (if the publication has one). Bibliographic description should end with a full stop.

The Vancouver Referencing Style, also known as the Oxford Referencing System, maintaining consistency throughout the article.
Examples

Monograph by no more than six authors:

Monograph by more than six authors. After the sixth author, the following abbreviation is placed: et al.

Chapter in the monograph (collaborative work)

Conference reports (papers)

Monographs published in electronic version

Articles in journals. Standard, list only six authors, above six – abbreviated: et al.

Subsequent editions of the monograph (Edition number is placed after the title)

Articles published in journal supplements

Articles in journals published in electronic version, with digital DOI

Articles in journals published in electronic version, found in the PubMed database.

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In view of the fact that since 2014 onwards, the quarterly journal will be published in the original electronic version in English, please translate into English: titles of articles in the bibliographic listing published in a language other than English, providing the language of the original in square brackets after the English title. The title of the journal must remain in full version or in functioning abbreviated form. Example:


The National Library of Medicine recommends placing the English translation of the title in square brackets, and information regarding the language of the article after the page

Example:


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  - **Figures** – should follow a consistent background colour scheme; do not use grid lines or shading.
  - **Tables** – standardized format, reducing grid lines to a minimum.

Example:

<table>
<thead>
<tr>
<th>Variable</th>
<th>A</th>
<th>B</th>
<th>d</th>
<th>Significance level p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age [years]</td>
<td>21.5</td>
<td>3.2</td>
<td>22.0</td>
<td>1.5 -0.5</td>
</tr>
<tr>
<td>Body height [cm]</td>
<td>176.2</td>
<td>3.3</td>
<td>178.0</td>
<td>4.1 -1.8 0.567 **</td>
</tr>
<tr>
<td>Body mass [kg]</td>
<td>68.3</td>
<td>2.7</td>
<td>79.4</td>
<td>3.5 -11.1 0.005 *</td>
</tr>
<tr>
<td>BMI [kg/m²]</td>
<td>22.3</td>
<td>2.2</td>
<td>25.7</td>
<td>2.8 -3.4 0.006 *</td>
</tr>
</tbody>
</table>

NS – statistically non-significant difference

* – p<0.05; ** p<0.05; ***p<0.001

- **Scanning.** The resolution of scanned illustrations must be at least 300 dpi. Black and white illustrations (lines of the art.) should be in TIFF format, or colour and images (grey) in TIFF or JPEG format (low degree of compression, up to 10%). All files can be compressed using RAR or ZIP; **Symbols,** for example: arrows, asterisks or the abbreviations used in tables or figures should be clearly explained in the legend.

- **Equations** must be written legibly, especially indices and exponents in powers.

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- Reviews are performed using the IC Publisher Panel review worksheet. **Reviewers are required to formulate a clear conclusion regarding approval or rejection of an article for publication.**
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**Veracity in Scientific Research and Respect for Intellectual Property:**
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- After translated, proofread and edited, the article is sent to the author(s) for approval. The publisher sets a one-week deadline for submission of further modifications by the author.
- Before publication, the author responsible for correspondence with the publishing office will receive the article by e-mail (in PDF format), edited in accordance with the journal’s style template, to obtain consent for its publication. At this stage of publishing, only minor, final modifications may be made. Delay in re-submission/consent may cause the article to be moved to the next issue.

Concluding remarks

- **Publication of articles in Antropomotoryka. Journal of Kinesiology and Exercise Sciences (JKES) is free of charge.**
- The author responsible for correspondence concerning the article receives a free PDF file with the issue of the quarterly journal, in which his/her paper is published.
- Abstracts and full texts in English and Polish are posted on the following websites: http://www.antropomotoryka.pl/ and http://970.indexcopernicus.com/.
- Subscription to issues of the journal published in book format can be ordered for a fee at: joanna.stepien@awf.krakow.pl.
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We are beginning the following year of our quarterly’s existence with the 77th issue. Volume-wise, it is no smaller than the previous ones which we have already been publishing for 26 years. As usual, we look into 2017 with confidence, but we are also aware of the growing financial difficulties of our main sponsor, the University of Physical Education in Krakow, and up until now, our fraternal university from Wroclaw. For nearly 10 years, we have been marching together in equal rhythm. We have been told that marching together is becoming weightier and we should expect that the next issue will be published only under the name of the University of Physical Education in Krakow. Let us hope that our editorial team manages to carry this weight. And perhaps, it will become necessary to move forward with the young generation in order for Antropomotoryka to continue its existence on the publishing market. Let us also have faith that the information provided at the beginning of the new year will not dampen the interest of readers to delve into the content of this next issue of the quarterly.

As usual, we filled up all of our journal’s sections. In the Exercise Sciences section, three articles can be found. The deliberations of our permanent and not always understood co-worker, who is only metaphorically called (with his own consent) ‘the Barbarian from the Palace of Science’, have been included with total premeditation. Ever since he started co-working with Antropomotoryka, he is faithful to his convictions shaped by the physiology genius N.A. Bernstein. In his next article, the author of a number of great feuilletons and discussions does not debate with anyone, but only reminds us what a canon is for him and what he has learned from Bernstein. It seems that it is worth reading the article to recall the main theses of the Great Scholar and to reflect not only on history but, above all, on how much history can be learnt by creating the study of human movement.

Two further articles were distinguished for their methodological approach to the study of human movement conditioning. The first reaches for biological and the other for psychological stimulants, which for various reasons, have so far been omitted.

In the Sport Sciences section, the authors’ attention was focused on the role of recreational physical activity in changing a very important metabolic component of physical activity in people affected by a civilizational disease, which is undoubtedly Type-2 diabetes (noninsulin-dependent diabetes mellitus NIDDM).

In Antropomotoryka, the cognitive aspect of sport activity could not be omitted. In an article in the Exercise Sciences section, authors discuss issues regarding motor stability and control of football players. An interesting research issue. Congratulations are in order for the authors due to their knowledge of the literature and the selection of research subject-matter.

The interesting results of a study on prison service officers from a Polish city presented in an article ending empirical dissertations point to the relationship between physical activity evaluated with the IPAQ (second version), supplemented with author’s questions about amount of leisure time, self-evaluation of physical fitness, number of performed sport disciplines as well as body height and mass.

The 77th issue of our quarterly had to end with sad news which reached us as we had just submitted texts for editing. And so, Prof. Maciej Demel passed away to eternity on January 27, 2017. An outstanding figure in the world of science, the creator of the original humanistic theory of physical education, considered as the process of preparing children and young people to participate in physical culture. The Demelian concept of physical education and health education was far ahead of the essence of fitness development in the health convention known as Health Related Fitness. Perhaps the biographers will not notice this thread in Professor’s activity. It would be difficult for the editor of Antropomotoryka, and earlier, its editorial secretary, to forget about this, because after all, his teachings have been saved in the memory of science, the teachings he had shared with us since the creation and becoming the co-editor of the Krakow journal. When he was lost for strength, he submitted his resignation. With heartache, we accepted Professor’s wish. I believe we have maintained and are still maintaining the assigned research course on physical fitness in the convention of health, unfortunately however, out of necessity and fashion for all that comes from oversees, we must refer to a different one of his author-
At our editorial office, we were not worthy to write even a short obituary about Professor. We turned to Professor Tadeusz Maszczak (Professor’s close associate) to share the brief reflection he gave at the plenary meeting of the Rehabilitation Committee, Physical Culture and Social Inclusion of the Polish Academy of Sciences on the role played by Prof. Maciej Demel in the pedagogy of physical education. We thank you for this gesture our Dear Friend.

What could the editor of Antropomotoryka add to these words, spoken in Polish through tears, which everyone should read in English. When thanks to information from Krakow Rakowicki Cemetery, I found myself with professors Wieslaw Osiński from Poznan and Marian Bukowiec from Krakow at the burial site of Professor Maciej Demel, hearing scraps of messages passed verbally by various people, I recalled the last years of the Great Scholar’s life. It was difficult for me to find the reason for the such short memory of those for whom he did so much, probably among them, the writer of these words. At the same time, I also thought: perhaps solitude in the last moments of life is a conscious choice of outstanding people, who leave this world with the words of Leopold Staff on their lips, the words which should not be translated into English:

Człowiekam kocha i przyrodę,
W przyszłość patrzyćm jasnym okiem,
Wielbiłem wolność i swobodę
Zbratany z wiatrem i oblokiem.

Nie wabił mnie spiżowy pomnik,
Rozgłośne trąby, huczne brawa.
Zostanie po mnie pusty pokój
I małomówna, cicha stawa.

Editor-in-Chief of Antropomotoryka
Edward Mleczko
It is difficult to make predictions, particularly about the future.
Mark Twain

Abstract

The author argues that contemporary mathematics cannot be as useful in biology as it is in, e.g., physics. Thus, in biology in general, and in motor control in particular, especially promising “knowledge ordering tool” seems to be the system-theoretical approach. Probably most advanced systemic theory of human motor behavior has been developed by N.A. Bernstein, who invented the five-level movements’ construction system (“brain skyscraper”). It is based on evolutionary and neurophysiological data, so its connections to particular classes of human motor operations are rather complex. Hence, the slightly simplified construct termed “modalities’ ladder” has been presented. It bases on Bernstein’s theory, so it has also five levels, but it “distills” mainly physical spatial and temporal relations, along with the codes of information processing, specific to particular levels. The various information processing modes determine both the speed and depth of it, and, consequently, the anticipation scope. In humans the accurate anticipation more than covers possible deficits of sensory organs (as compared with animals). In contemporary civilization it is necessary in daily activities, e.g., in car driving.

In practice, the crucial factor is the temporal scale of information processing at particular levels. This enables clear distinction between simple moving, technique, tactics, strategy and politics in motor operations and joining them with the information processing specificity at A, B, C, D and E level, respectively. Furthermore, it leads to formulation of the “inverted V-principle” that mirrors the specific function of C-level motor habits in performing any real motor operation.

Sport is a field of human activity where the perfection (though not necessary the sense) of a motor operation is of crucial importance. Thus, the reliable anticipation that enable production of a response before an appropriate stimulus appears is decisive. The analysis of “anticipation ladder” has been exemplified with the boxing knock-out.

In contemporary sport, an athlete may benefit from anticipation performed by other specialist, e.g., instructor, coach or scientist. Especially the latter needs highly developed and unconstrained anticipation to invent new, more and more effective solutions of sport motor tasks, i.e., first of all, the technique and tactics.
A spectacular recent example is the Nobel Prize for P. Higgs, awarded for half century old “scientific daydreaming”. Another brilliant illustration of this statement is the detection of gravitational waves, predicted by A. Einstein already a century ago.

Unfortunately, biological sciences – among them also motor control – are not so fortunate [2, p. 12]. Here the cause-effect chain includes a stimulus, an information – which has to be identified and processed – and only finally a response (no longer a sheer reaction!) Hence, already in 19th century C. Darwin has stated that “a mathematician is a blind man in a dark room looking for a black cat which isn’t there”. It may be regarded as a trilling, slightly malicious joke, indeed. However, one might also trace here the idea that mathematics is not an universal and omnipotent “Queen of Sciences”, but a discipline with limited “field of fire”, as each other one. Especially, it is not able to deal with the issues of living beings.

Probably most significant difference between physical subjects, describable mathematically, and living organisms, not describable (in general) mathematically is that the former is completely indifferent towards future, whereas the latter is aimed at bringing about specific results just in future. According T. Gánti, a living organism “must have a subsystem carrying information which is useful for the whole system” [3, p. 78]. This information is aimed at bringing about specific, desirable effects in the future. Even the cellular membrane – unlike any physical object – somehow “knows”, what substance to let in, and what – to pump out.

So, contemporary mathematics seems to be hardly useful for describing and explaining the biological issues in general [4, p. 4; 5; 6, p. 161], and the motor control issues in particular [7]. Thus, scientists dealing with that matter have to use another “order bringing tool” than elegant, apparently fully reliable, fashionable and “user friendly” mathematics.

The term “user friendly” needs a comment. To become able to make use of it, the scientist has to learn the specific “language” of mathematics, and especially its formalism. Unfortunately, it is often ununderstandable for non-mathematicians, what makes a significant barrier of its applicability in sciences other than, e.g., physics. This was concisely expressed by J.W. von Goethe, who stated: “mathematicians are like Frenchmen: whatever you say to them they translate into their own language, and forthwith it is something entirely different.”

In this respect the system theory seems to be especially promising. For its invention L. von Bertalanffy [8] is credited. However, already in the beginning of 20th century, A.A. Bogdanov [9] created the systemic “general science on organization” which he termed “tektology”. In 1947 Bernstein invented a systemic concept of movements’ construction in living creatures [10; 11; 12]. Both the von Bertalanffy’s and Bernstein’s theories were rooted in biology, whereas Bogdanov’s model – who regarded mathematics “as an earlier developed, because of other reasons, branch of general science on organization” [9, p. 9] – was essentially more general.

1. System thinking

The system may be defined as a goal-aimed, organized set of ideas, biological structure, or technical device which is able to generate a qualitatively new ability or phenomenon (emergent), not resulting directly from traits of any of its components.

According to Morawski [13; 14; 15, p. 162-163], the system is built in keeping with the following axioms:

1. The layers hierarchy axiom: In each system there is a main control layer (“master”), and the other, background layers (“slaves”) support it.

2. The layers autonomy axiom: Each layer performs its specific tasks independently, without any additional information.

3. The scales’ conformity axiom: Each layer has its own thinking specificity (information processing code and logic), time-space dimensionality, and energy exchange range.

The modality of information processing, including, e.g., temporal relations, as well as specific code and logic of such process, determines the “identity” of a given layer and its potentialities. Hence, the scales’ conformity axiom would have well be termed “layer’s identity axiom”.

A system unifies several layers – each of them dispos- es of specific potentialities – and just the ability to use one of them as a “master” to solve a given task makes it so versatile and efficient. Summing up, one might state that:

1. The system makes a coherent – yet not homogenous – unit; it has a discrete structure.

2. The particular elements of a system – real or abstract – are linked with each other by specific relations and make an active cause-effect chain.

3. In the system emerges a qualitatively new, unpredictable system effect (emergent) which cannot be directly deduced from the capabilities of its elements.

2. Motor control in humans – a syste m-theoretical approach

Let us term “operation” a goal-aimed human motor activity, intentionally planned and controlled. In motor control a milestone was the concept by Bernstein [10; 11; 12]. On the basis of many years analysis of then existing theories of motor control, especially the reflex theory by I.P. Pavlov, in 1947 he presented the five-level movements’ construction system in humans. Basing on thorough evolutionary, biological, and neurophysiological
knowledge, he applied what is nowadays termed “infer-
ence to the best explanation” [16] and made two crucial
steps on the way towards the theory of human motor
behavior. Firstly – he followed the evolutionary develop-
ment of living beings, projected it onto the structure of both
human central nervous system and working organs and
discerned specific neural units responsible for particular
motor potentialities. Secondly – he organized those units
into a system consisting of five particular levels which he
termed “brain skyscraper” (BS) [11, p.121; 12, p. 99].
It underlies the systemic model of movements’ construc-
tion in humans, qualitatively different from the theory of
reflexes by I.P. Pavlov. The latter – despite of attempts
made by A.A. Ukhtomsky [17, pp. 7-106], who developed
theory of the dominant – cannot satisfactorily explain the
phenomenon of anticipation. Symptomatically enough,
even P.K. Anokhin, outstanding disciple of Pavlov, clearly
“deviated” from the reflexive and turned to systemic way
of thinking [18].

In the works by Bernstein one might trace the follow-
ing main principles:
1. The chief level principle: During motor operation only
the main (“master”) level needs focusing of attention.
2. The background level(s) independency principle:
The background (“slave”) levels work without atten-
tion focusing.
3. The lower levels’ development principle: The forma-
tion of a higher level enhances the capabilities origi-
nally ascribed to lower ones.

In the course of evolution newer, higher and more
powerful floors grew up from lower ones. For example,
according to motor theory of language by R. Allott, the
speech has been founded on neural structures primar-
ily developed for movements’ control [19]. The higher
“floors” of the BS took over some tasks from lower, less
sophisticated ones, whereas the higher levels endowed
the lower ones with some potentialities specific to those
higher levels. Hence, one might discern up-down “di-
rect control” and down-up “outsourcing”. In the former
the chief level (“master”) directly controls the action of
background levels (“slaves”). It is not possible in the
“outsourcing” mode, because information processing
at higher levels is slower than that at lower ones. Thus
the higher level (“contractor”) has to be “committed” in
advance to solve a given task, if it is too difficult for the
lower, operation managing one, and only then to “send
down” the ready solution to that lower level (“client”).
This is practical manifestation of the third Bernstein’s
principle. As a consequence, the whole structure of the
BS became slightly “fuzzy”, and unambiguous assigning
of particular class of motor operations to a specific floor
turned out to be hardly possible.

Thus, it seems reasonable to develop a structure of
“modalities’ ladder” (ML). It is embedded in Bernstein’s
theory, so its “rungs” are parallel to particular floors of
BS, but it is significantly simpler (Tab. 1).

As compared to original Bernstein’s theory, the A-
level has been divided into two sub-levels: A0, respon-
sible for “absolutely basic” muscle tonus, necessary for
posture keeping, and A, responsible for a single muscle
contraction. As one may learn from the Tab. 1, the BS
is of rather neurophysiological nature, whereas the ML
is focused on information processing peculiarities. The
“bridge” joining them are the classes of particular mo-
tor skills. However, the differences between neurophys-
iological and psychological bases of the BS and the ML
brought about some asymmetry concerning A0 level. In
BS it makes a basis for “sensorimotor” A, B, and C levels
only, whereas in ML the A0 consciousness of the appro-
iate modality underlies each and every central nervous

| Table 1. The Bernstein’s “brain skyscraper” and the “modalities’ ladder” adjoining it |
|---------------------------------|---------------------------------|---------------------------------|
| **Brain skyscraper** | **Motor potentials** | **Modalities’ ladder** |
| E | No motor operation, **politics** | E |
| D | Performance, **strategy** | D |
| C2 | Habit, tactics, dexterity | C |
| C1 | Habit, tactics, agility | |
| B | Automatism, **technique** | B |
| A0 – Muscle tonus | Template, contactception | A |
| A | Reflex, strength control | A |
| A | Coupling, proprioception | |

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system’s activity, from that underlying A-level activities through general theory of relativity invention (level E).

The simplification of ML consists in “distilling” from each of Bernstein’s levels only the most “physical” element (and thus quite easily graspable), i.e., the information processing modality. It includes the code (and, consequently, the logic) of information processing, along with the spatial and temporal dimensionality, in which the given modality is embedded.

It seems worth noticing that in Tab. 1 the words “reflex” and “automatic” are used, and not the terms “unconditioned reflex” and “conditioned reflex”. Both the latter, traditional names may suggest that they are two varieties of essentially the same phenomenon. However, it is not true. They are controlled by different floors of the CNS, and are differently developed: the former is “hardwired” and hardly liable to any modifications, the latter has to be actively molded. And, finally, they play different functions in the general structure of human motor operations.

Particular “rungs” of ML are embedded in Bernstein’s BS construction, indeed, but the association is rather flexible. So it is possible to establish quite arbitrarily specific criteria of ML construction. Lower, “sensory rungs” may be associated with proprioceptive (A), contactceptive (B), and teleceptive (C) control mode. Higher, “mental rungs” include purely abstract (i.e., detached from immediate sensorial experiences) representations of reality. At “geometrical” D-level there are rigid temporal and spatial “frames”, truly mirroring the reality, to which events have to be adjusted. This may be termed “common reason”. At “topological” E-level the situation is opposite: the event is rather “stiff”, whereas the spatial and temporal constraints have to be adjusted to it. This level may be termed “fantasy”. Such an arrangement of particular “rungs” remains in keeping with the original Bernstein’s theory, but it makes the whole system simpler.

The detaching of information processing from the current environmental stimuli enables extending the temporal scale of analyses far beyond the limits marked by sensory organs (A, B and C levels). Hence, the anticipation and prediction at mental D and E levels may reach much further into future than that basing on current sensory information.

3. Specificity of particular “rungs” of the modalities’ ladder

The A-level modality enables perceiving one’s own body as a whole universe; B-level modality – as a center of universe. At C-level, thanks to teleceptive sensory organs, happens what might be termed “Copernican revolution”: one gets ability to perceive one’s own organism not as a center, but as a part of by far more extensive universe. Those levels base on current sensory experiences. The most advanced of them – the teleceptive ones – enable perception of only a short portion of time axis. On the other hand, D-level enables building a mental representation strictly parallel to reality, including whole time axis, whereas E-level – a mental representation free from any spatial and temporal constraints. Referring to views of M. Nadin [20, p. 511] one might state that in humans the discovery is rooted in A, B and C, whereas the explanation – in D and E levels. However, inevitable price for extending the temporal scale of anticipation is detaching the reasoning from current environmental stimuli and shifting it wholly into the sphere of abstract mind.

The simplification of the ML as compared to original Bernstein’s BS includes detaching of particular levels from their neurobiological roots. Hence, they are easier graspable, and include only physical spatial and temporal dimensions.

The former may be ordered rather easily. A-level may be associated with one-dimensional muscle contraction; B-level – with two-dimensional joint rotation; C-level – with three-dimensional movement in space; D-level – with abstract “geometrical” representation of the real space, including existing spatial constraints; E-level – with abstract “topological” representation of the real space, free from factual spatial constraints. Accordingly, specific motor abilities may be assigned to particular ML “rungs”: the strength – to A-level; the speed – to B-level; the agility (whole body, C1) and dexterity (working organs, C2) – to C-level; the expertise – to D-level; and the invention – to E-level. In such a system it is clearly visible that information processing organization in a human makes one coherent (yet not uniform!) system, from the simplest A-level patellar reflex to the mental E-level hunting for Higgs boson. Moreover, purely mental D- and E-level abilities (expertise and invention) make a logical extension of sensorimotor abilities at A, B, and C levels. This remains in keeping with the way of thinking by R. Allott [19]. However, because of releasing from real constraints, the former are more versatile.

More complicated is the problem of temporal relations, because they may be grasped only indirectly. As already in 17th century I. Barrow, I. Newton’s teacher, remarked, “time implies motion to be measurable; without motion we do not perceive the passage of time” [21, p. 35]. However, to perceive any motion, the C-level teleception is necessary. The “Copernican revolution” at that level extends the area of perceivable reality so much that C.S. Sherrington stated that “just the teleceptors made the brain” [10, p. 9].

The C-level time perception includes only a small portion of the whole time axis. It is termed “object permanence”. P. Gärdenfors [22, p. 39] wrote: “The cat can ‘think’ of the mouse even when it is receiving no signals from its senses; it can for example, wait outside a mouse hole”. 
Anticipation, a multimodal phenomenon

The object permanence underlies the awareness that something exists, though it is at the moment not detectable by senses. This concerns also the subsequent positions of the same object, what makes a basis for motion observation and thus — indirectly — time perception and anticipation. By the way: according to S. Dehaene, the object permanence makes a basis for elementary “number sense”, i.e., what may be termed “embryonic mathematics” [23, p. 48].

Time perception at C-level includes only small portion of the time axis. It may be exemplified by “time to contact” phenomenon [24, p. 141]. In motor control it makes a basis for phenomenon termed “timing”. According to A. Hotz [25, p. 169]: “Timing is the temporal punctuality towards a spatial point, and also the functional potential to be at proper time, with optimum speed and in relevant place”. Thus the timing obviously needs anticipation.

Very important is that the higher level, the deeper, but also more time-consuming information processing (i.e., the “longer” temporal scale). As Z. Chlewiński [26, p. 283] remarked:

For example, the images are being remembered quicker than words, and the words which designate the specific notions recall the respective images faster than the words which denote the abstract notions.

In the ML the images may be assigned to C-level, the words which designate the specific notions — to D-level, and the words which denote the abstract notions (symbols) — to E-level. From semantic perspective, the D-level might be, roughly, associated with primes, whereas the E-level — with universals [27]. Moreover, the lower level, the less vulnerable to any disturbances.

Summing up, the time perception might have arisen only at “teleceptive” C-level. Hence how can it work at “contactceptive” B-level? For this phenomenon the third Bernstein’s principle (lower levels’ development) and “outsourcing mode” information processing is responsible, underlying habits formation. The example of such “outsourcing” may be found in I.S. Beritashvili’s achievements, so described by M.G. Tsagareli [28]:

By subtle experiments he (Beritashvili – WP) demonstrated that the stimulation of labyrinthine receptors during animal locomotion is very important for spatial orientation in the environment, and that proprioceptive excitation did not participate in the production of the image of the route the animal had travelled. But in repeated traversing of the route the stimulation of these receptors turn into conditional signals for movements that then proceed automatically as chain-conditioned reflexes.

Summing up, one might state that in ML perspective the A-level is one-dimensional; B-level — two-dimensional; C-level — three-and-fract dimension; D-level — four dimensional, “geometrically rigid”; and E-level — four dimensional, “topologically flexible”.

4. Reactive and active motor behavior

In the course of evolution, first appeared the sensivity. Next was the responsiveness [11, p. 66; 12, p. 50]. Primarily, information processing between stimulus and response was practically equal to nil and the stimulus was nearly directly coupled with the response. In the “matured” responsiveness between them appeared an information which had to be recognized and processed. Just this makes the basic difference between physics and biology. Thus the whole process of information processing in living beings became more complex — the information depends on both species’ and individual’s experiences — and slow, but at the same time flexible. As it M. Heller stated, “the notions, while already born, multiply and mutate quicker than biological species” [29, p. 32]. Hence, just the ability to produce the mental representations of the reality may be regarded as mainly responsible for acceleration of evolutionary processes, which finally resulted with formation of Homo sapiens.

To analyze human motor behavior, it is necessary to define the following terms:

Stimulus — in motor control: a physical phenomenon, in itself not “understandable” to the nervous system, which excites a human sensory organ and forces it to produce a sensory input, recognizable and processable by the central nervous system.

Signal — in motor control: a neutral stimulus which fore-runs another specific stimulus; it may start in advance the process of thinking aimed at preparation of a goal-aimed action (anticipation).

Releaser — a stimulus, which in fact triggers a response production and operation execution process.

What might at first glance seem to be paradoxical, in ontogeny first develop the B-level synergies, and only then the A-level muscle tonus [11, p. 124; 12, p. 102]. Accordingly, at first a newborn is able to perform merely the disordered movements, and only when the A-level muscle tonus gets matured enough (a newborn raises the head) it appears a base for construction of goal-aimed motor operations.

In contact with the environment, at first the contactceptive (B-level) responsiveness appeared. The response was possible only after recep­tion of a releaser. Along with creation of C-level remote sensitivity, preparing of a response already after reception of a signal — in the frames of timing — became possible. Hence the response initiation has been transferred before the releaser appeared. This made the essence of anticipation.

Here ended the potentialities of response acceleration with sensory contribution. To shift the moment of response initiation still further before releaser reception, the complete detaching of information processing from sensory experiences and D-level modality was neces-
sary. Symptomatically, at the highest “sensory” level, the C one, appear the germs of conscious time perception that make fundamentals for active anticipation.

For description of production of a response directed towards future, it is necessary to determine (the term “define” would be here an “overstatement”) the following basic terms:

**Uncertainty** – doubts concerning future course of events. **Expectation** – passive waiting for imagined future development of situation. **Anticipation** – imagination (burdened with uncertainty) of future events, usually in order to actively influence the course of those events.

The latter may be traced already in lower organisms. In 1915 E. Heron-Allen described an intelligence in Foraminifera [30]. Also H.S. Jennings described the psychic aspects of lower organisms’ behavior [31, pp. 328-337]. Still earlier C. Darwin [32, p. 97] wrote:

> If worms have the power of acquiring some notion, however rude, of the shape of an object and over their burrows, as seems to be the case, they deserve to be called intelligent; for they act in nearly the same manner as would man under similar circumstances.

Also physicist Feynman [33, p. 91], while watching a Paramecium, discovered some astonishing signs of goal-aimed behavior which might be termed “intelligent”. All this remains in keeping with one of the absolute criteria of life by T. Gánti [3, p. 89] that “a living system must have a subsystem carrying information which is useful for the whole system”.

Intelligence bases on two “pillars”, anticipation and logic. They determine the goal of action, and correctness of joining the cause-effect chain’s links, respectively. Both they are specific to a particular ML level. However, if for anticipation a time perception is necessary, which appears only at C-level, then how the organisms that do not dispose of teleceptive sensitivity may anticipate?

To use intelligence, it is necessary to know all the data necessary to solve a given task and all the rules of producing the suitable cause-effect chains. Unfortunately, the future always includes an element of uncertainty. Here the guessing of lacking information is necessary; this is being done by intuition. In a word, one might say that the intelligence is necessary for engineer, whereas the intuition – for scientist.

The anticipation in lower organisms is evolutionary molded and inherited. It may be termed “passive anticipation”. If in a given situation it turns out to be incorrect, the organism usually dies. However, the C-level creatures may develop “active anticipation”, along with the primeval time perception. The creatures which dispose of such mode of anticipation may change their behavior patterns. In such situation the wrong abstract behavior patterns may “die” instead of real organisms. According to third Bernstein’s principle, in C-level creatures time perception may involve also the lower levels, which independently would not be able to mold the active anticipation.

5. Simple moving, technique, tactics, strategy and politics in motor control

The presented specificity of particular “rungs” of the ML enable clear distinction between simple moving, technique, tactics, strategy and politics (Fig. 1). They are basic phenomena in sport, as well as in daily life, and all they base on anticipation.

The muscle contractions at A-level enable simple moving. As Bernstein described it, it is “background of all backgrounds” [11, p. 139; 12, p. 115].

Technique may be assigned to B-level. Technical skills – both created as a result of A-level reflex diversification (down-up), or C-level habit automation (up-down) – base entirely on contactceptive control. Tactics may be assigned to C-level. Tactical skills base on teleceptive (mainly visual) control. Strategy may be assigned to D-level. It is completely detached from the current sensory experiences, bases on abstract anticipation of a response construction. It is of geometrical nature, i.e., it takes into account the current spatial and temporal constraints.

Politics may be assigned to E-level. Alike strategy, it is also detached from the current sensory experiences, but it is focused on creation of such constraints which will be favorable for future solution of a given task. Hence, it is of topological nature.

This might be well illustrated with the graph of structural ordering, invented by J.M. Morawski [15, p. 166; 34], as shown in Fig. 1.

The accurate anticipation is especially important in humans. Already long ago technological progress outdistanced the evolutionary development. For example, maximum speed which a human is able to achieve amounts to about 10 m/s. On the other hand, a passenger car moves at a speed about four times, and F1 car – about ten times higher. It would not be reasonable to equip a human by evolution with sensory potentialities able to meet such requirements. Thus here instructive seems to be the following statement by outstanding racing driver B. Collins:

> What defines a good driver? What attribute is necessary, and what merely useful?

> The anticipation. Racing driver is a person, who does not look for solutions of the problems that occur in a race. He knows those solutions, and when the situation comes, when the reaction becomes necessary, he/she simply performs the operations leading to its successful solving [35].

Accordingly, a driver has to realize operations with C-level speed and D-level information processing depth.
Hence, to face up to needs of daily life, a human has to substitute the sensory C-level deficits with accurate, skilled D-level anticipation. Moreover, it seems that just the potentiality to quite accurate anticipation of future events makes a chief advantage of human over animals.

6. Anticipation in human sport operations. Inverted V-principle

As I.M. Feigenberg [36] aptly remarked, all the motor operations of living creatures are somehow directed towards the future. In practice, the crucial factor in applying A-level reflexes, B-level automatisms, C-level habits, or D-level performances are temporal relations; according to Bernstein, E-level does not control any real activity [11, p. 193; 12, p. 165].

The swiftest are A-level reflexes, B-level automatisms are slower and C-level habits – still slower. Nevertheless, the latter include information processing that may be synchronized with the events that happen in reality. D-level performances are usually slower than the real course of events.

On the other hand, the latter are most flexible, i.e., they may be best “tailored” to a current situation, whereas the former are nearly completely rigid. Thus, the interplay between particular levels is in fact a trade-off between speed and flexibility.

In ML perspective reflexes, automatisms, habits and performances may be joined with proprioceptive, tactile, visual and verbal stimuli, respectively. In daily practice, the C-level habit makes probably optimal combination of speed and flexibility. This might be shown as an “inverted V” (Fig. 2). It may directly control the fast lower levels (“left leg” in Fig. 2, “assistants”), and cooperate in “outsourcing” mode with the slow higher levels (“right leg” in Fig. 2, “consultants”).

In Fig. 2 it is clearly visible that C-level is able to manage both “on-line” anticipation (“left leg”), controlling ad hoc the simple reflexes and automatisms, and the complex performances, molded as a result of previous “outsourcing” (“right leg”). Thus, just the C-level, where the most important information carriers are images, determines the level of efficiency of human’s skilled action. In the literature it is termed “visual dominance” [37, p. 99].

Though humans share with animals geometrically arranged real world, the latter did not develop the “right leg” of inverted V (D- and E-level modalities), where the far-reaching anticipation “resides”. Thus, Beritashvili showed that in animals just the vision underlies the most advanced motor behavior patterns [28]. In daily practice also humans rely mainly on C-level habits and tactics.

One might exemplify a C-level action with cycling. If one sees a puddle before the bicycle, he/she does not process a verbal information, but takes an action to place the image of front wheel beside the image of the puddle. Thus the whole information processing happens at visual level.

Closer examination of the Fig. 2 leads to one more conclusion. To make a verbal, abstract D-level anticipation useful in practice, it has to be reduced to the C-level that represents the reality. Hence from the whole time axis only a small portion has to be cut out, and thus the dimensionality of information processing is being reduced from D-level four to C-level three-and-fraction. Such phe-
nomenon may be regarded as another aspect of Bernstein’s degrees of freedom reduction principle.

Sport is a specific human activity. Nature does not break records: Nature solves tasks. Only humans’ striving for individual’s supremacy, along with development of D and E levels, resulted with development of sport. Wolański [38] wrote:

High-performance sport as a motor activity makes a certain degeneration, because (…) it is not a way of adaptation to environment, so it has nothing in common with promotion and supporting of health.

Accordingly, rationality of sport may be brought into question, indeed, but it strives for motor operations perfection and moves farther and farther limits in this respect. From that perspective it may be of special interest for human motor behavior investigators. The somatic abilities needed by an individual in sport may be divided into two groups:

- Strength, speed, agility and dexterity (time as events’ ordering factor),
- Endurance (time as events’ duration measure).

In the former time brings order into the sequence and intensity of particular muscle contractions, in the latter it is only a measure of duration. Consequently, one may speak about strength (A), speed (B), agility (C1), and dexterity (C2) endurance, as well as purely mental – expertise (D) and invention (E) endurance.

Each discipline includes both these kinds of abilities, though their shares differs from discipline to discipline. Some of them are performed in highly predictable environment, e.g., gymnastics, figure skating, running, swimming, rowing etc. (closed skills). Other disciplines need adjusting to environment and active anticipation, e.g., combat sports, games, sailing etc. (open skills).

While analyzing real motor operation, one might consider A-, B-, C- and D-level anticipation. The former may be associated with the specific moment of muscle contraction and its intensity. It makes a basic element, of which all the motor operations are built (“background of all backgrounds”, as by Bernstein). Analogously, the anticipation at A-level makes an “anticipation of all anticipations”. It determines the relation between motor command and muscle contraction. It is not accessible to any instruction and has to be developed independently by an athlete.

The B-level anticipation may be ascribed to technique, reduced to tactile level and, according to Bernstein’s theory, performed usually without any attention focusing (gymnastics, figure skating, running, swimming, rowing etc.). In, e.g., swimming it is termed “feel” for the water [39, p. 278]. Too slow motion of the hand will produce too low propulsion force, but too fast motion may disturb hydrodynamical flow about hand and diminish the propulsive force, too.

The C-level anticipation, where the tactics is embedded, is decisive in current motor performances analyzed in the scope of timing. Here one may use the C-level behavior patterns (habits) which control ad hoc the B and A levels (technique and simple moving, respectively), or the programs, previously prepared at D-level (performances) an then reduced to the temporal scale of C-level. The anticipation at C-level may be illustrated with the experiment by I.N. Salchenko [40, p. 47-51]. He proved that experienced fencer notices hardly visible signals (“body language”) and may response to actions of his/ her opponent even before a respective releaser appears.
However, when a part of opponents body is obscured, his/her advantage is considerably reduced, sometimes to nil. The function of C-level anticipation is here obvious. It is necessary in, e.g., combat sports, where the independent, current D-level information processing would be too slow.

The D-level anticipation is important in such sports like, e.g., sailing or chess, where it has to reach far beyond actual sensory experiences. Here an athlete has time enough to observe the positions of opponents, wind force and direction, waves and currents and to analyze them at verbal level – rather slow, but appropriately deep.

To another division shows Feigenberg [41, p. 34]:

- Sports without actively counteracting opponent,
- Sports with actively counteracting opponent.

The latter is more complex. The chain of D-level anticipations Feigenberg illustrated with the poem "The Kiss" by C. Patmore:

'I saw you take his kiss! 'Tis true.'
'O, modesty!' Twas strictly kept:
He thought me asleep; at least I knew
He thought he thought he thought I slept.'

Such a “tree of anticipations” might be compared to the "fig tree" by M.J. Feigenbaum [42; 43; 44, p. 543; 45, p. 335]. Accordingly, for description of such situation the analysis in terms of chaos theory seems to be relevant.

From Bernstein’s theory it results that each level has to have its own, specific modality. It includes also a specific logic, necessary for any anticipation. For example, while facing a grizzly bear in Alaska, it is better to be accompanied by experienced trapper (C-level skills) than a Nobel laureate (E-level competences). It is worth mentioning that the lower level, the less vulnerable to any disturbances. This issue may be well illustrated with analysis of a severe knock down in boxing [46] as seen from ML perspective. After extreme strong hit the boxer suffers concussion and losses consciousness. Then he/she gradually comes around. At first the most primeval – and most resistant to any disturbances – A-level muscle tonus returns. Then – the B-level synergizes; the boxer regains ability to move. Third – slowly and gradually reappear C1-level agility and C2-level dexterity. At that moment it seems – apparently – that the athlete is anew ready to fight: he/she takes position, moves his/her body and extremities properly. One may place it at the apex of the inverted V (Fig. 2). However, in such situation the “inverted V” has yet no “right leg”. Attentive observer may notice that the boxer is fuddled and may use only the C-level habits (elementary tactics), so he/she is able to fight only conventionally, as learned in trainings. The higher D-level functions – with ability to anticipate and to develop actions original, inventive, embedded in strategy, as well as to foresee the actions of the opponent – disappear. Accordingly, his/her style of fight becomes reactive only, and not active. Usually he/she is able to perform mainly defensive, and not offensive actions. It is clearly visible that even short break in fight – if the boxer manages to last out it – makes an important life-ring for him/her, because it gives some time for restoring, as much as possible, the strategical abilities. Hence in boxing competition both the responsive body and the anticipating mind are fighting, which are responsible for current and for future actions, respectively. After severe knock down the latter is either more or less severely dimmed, or even completely switched off.

By the way: In this respect highly instructively sound the following words by W.W. Klitschko after defeat by T.L. Fury:

I was in the best physical shape of my life. But no physical form will help unless it’s combined with a good psychological condition. It was not an injury. (…) I felt the distance. I was thinking too much … about counting. I had to work on instinct, that killer instinct. I kept waiting for something and the opportunity to fix things. I got uncomfortable, and all of this has caused some fatigue, discouragement, even confusion [47].

It is worth noticing that at C-level teaching by imitation of behavior of more experienced individuals becomes possible. This may be associated with mirror neurons [48]. The invention of language dramatically extended the communication and teaching potentialities, hence it enabled making use of scientific achievements in sport. Thus, an athlete may benefit not only from his/her own anticipation, but also from anticipation results worked out by instructor, coach or sport scientist. It may be exemplified by flop technique in high jump. It seems hardly possible that an athlete, without profound physical knowledge and scientific equipment, would be able to develop such a movements’ pattern on his/her own. It was no doubt result of invention supported by scientific calculations, not possible “on line”, during just being performed operation.

Conclusion

We live bodily in Euclidean, sensorily detectable world including A, B and C levels, but we are able to make mental excursions to purely abstract “geometrical” D and “topological” E levels. Already in 18th century J.O. de La Mettrie remarked: “But if the brain is both well organized and well educated, it is like perfectly sown, fertile earth which produces a hundred-fold what it has received” [49, p. 22]. P. Gärdenfors [22, p. 55] quotes contemporary novelist T. Pratchett, who stated: “Daydreaming got us where we are today; early on in our evolution we learned to let our minds wander so well that they started coming back with souvenirs”. Also A. Einstein remarked: “Logic will get you from A to B. Imagination will take you everywhere”. Thus in the course of evolution the “taming the future” with anticipation, even burdened with un-
certainty, turned out to be more effective than “mastering the present” with even perfectly tuned sensory and working organs. Just in such “beyond senses” future N.A. Bernstein and L.M. Feigenberg located fundamentals of what they termed “model of desired future” and seat of “probabilistic prognosis” [50].

The term “probability” might be described as an anticipatory framework that controls the field of motor control science. Highly symptomatic are the words by Bohr, who stated that “everything we call real is made of things that cannot be regarded as real”. They concern physics, indeed, but remain in force – all the more – also in motor control, which is nearly entirely woven of psychological “threads” that “cannot be regarded as real”.

The final conclusion may be well illustrated with the following remark by M. Nadin: “science was born together with the magical, and would continue to develop in this symbiosis” [20, p. 512]. However, if after the words “with the magical” one would add still “and poetry”, its meaning gains another “intellectual hue”. Symptomatically enough, N. Bohr stated:

We must be clear that when it comes to atoms, language can be used only as in poetry. The poet, too, is not nearly so concerned with describing facts as with creating images and establishing mental connections [51, p. 12].

In fact, just the “establishing mental connections”, much closer to poetry than “naked” experimental results, makes the very heart of science. To use the metaphor by H. Poincaré, “an accumulation of facts is no more science than a pile of bricks is a house”. Moreover, the magical (and poetry) includes some freedom of thinking, necessary in science development, but often strangled with the strict formalism or commonly acknowledged methodology. The latter puts the knowledge in order, indeed, but at the same time kills the inventiveness. So, without fantasy only a bare development is possible, and not the creative progress. Hence – however paradoxically it might sound – just the mysterious and infrequently deceitful magical, along with elusive poetry, apparently far from “hard reality”, make together a fertile ground for sober, reliable anticipation. However, forging such reliability is very arduous process, with numerous misleading paths, traps, and dead ends. Nevertheless, its product, i.e., the trustworthy prediction, is the most desirable and highest valued outcome of science.

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Anticipation, a multimodal phenomenon

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HEALTH RELATED FITNESS (H-RF) OF OBESE AND OVERWEIGHT CHILDREN FROM THE MALOPOLSKA REGION – PART 1. GIRLS

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Keywords: population research, girls, age 9-18, Quetelet II Index, efficiency referring to health (Health-Related Factor), coexistence, correlations, concentration analysis

Abstract

Introduction. In the studies on somatic determinants of functional and motor development of children and adolescents to date, an important place is occupied by the issue of the relatio-ionship between being overweight and obese and the positive measures of health, including: physical efficiency and fitness.

Aim of research. Based on the results of research conducted among 3,221 girls from the Malopolska region in the years 1996-2005, we decided to verify the hypothesis that there is a negative effect of being underweight as well as obese during the studied ontogenetic period, effecting the level of positive measures of health and the similar structure of the subject’s physical fitness in the convention of health. Additionally, the aim was to study the strength of the correlational relationship between too low and too high fatness level on positive health measures. Furthermore, we studied the similar structure of physical fitness and efficiency ana-lyzed within the context of health and the similar strength of the correlation between its ele-ments and the height-mass index (Quetelet II index) in the extreme groups of BMI variability.

Methods. The results of positive health indices were analyzed, including: basic somatic features, anthropometric indices, oxygen efficiency (VO2 max), motor ability tested using the Eurofit and MTSF tests. Based on the average value and the standard deviation of BMI, all of the tested girls were divided into 3 age groups: 8-10, 13-14, 17-18. For each of them, the dif-ferentiation range and trend of the considered features was discerned. Only in two groups (above and below the range of 1 SD BMI) was concentration analysis conducted, where the strength of the correlation between the elements of the physical efficiency structure and BMI level were calculated.

Results. The research confirmed the adopted hypothesis regarding the negative influence of low and high fatness levels on selected indices of positive health, directly tested using BMI indices. The results of concentration analysis and Pearson’s correlation coefficient between BMI index and the tested physical efficiency elements referring to health show reason to claim that there are similar connections between the elements of physical efficiency and hier-ar-chic structure in the group of individuals with low and high fatness. Statistically significant correlations were only found between efficiency of morphologic components and BMI.

Conclusion. The conducted research confirmed: 1. The negative influence of too low and too high levels of fatness on the level of positive health indices, 2. A statistically significant correlation only found between BMI and the somatic features which measure the body’s fat-ness, 3. Poor relationships between BMI level and positive health measures, such as: physical efficiency, motor ability, 4. Similar structure of physical fitness tested within the context of health in groups of lower and higher levels of fatness.
Introduction

In numerous works by Polish and foreign anthropologists, auxiologists and anthropomorphologists, there is strong evidence of the negative effects of excessive as well as very low levels of fat in the human body mass on many vital functions that determine the desired standard of living and even its length. In recent years, positive health indicators more frequently include physical fitness and efficiency as well as low fat levels.

Their accurate measurement requires laboratory testing. For prophylactic purposes, indirect methods of estimating their levels are recommended based on easier-to-measure features or quotient ratios. Among them, the Quetelet II mass-height index, also called the Body Mass Index, has been used to determine the level of overweightness and obesity for more than thirty years. This is evidenced by the determined very high correlation between human fat mass (FM), as measured by such methods as Dual Energy X-ray absorptiometry (DXA), bioelectric impedance or anthropometric techniques [1-9]. Most commonly, the range of correlation coefficients was within the range of \( r_{xy} = 0.52-0.89 \) in boys and \( r_{xy} = 0.50-0.87 \) in girls. A significantly lower range of high potency variability was observed when evaluating the relationship between BMI -% FM (\( r_{xy} = 0.85 \) for boys and \( r_{xy} = 0.89 \) for girls [10]).

Despite the high correlation between the two variables in interpreting the phenomenon of overweightness or obesity using only BMI, attention is drawn to the limitations of such a method of evaluation. Similarly as in the case of using any indirect method, there is a measurement error. In children, this is reflected in the rate of biological maturation [11, 12], body height [13] and body build type [9, 11, 14].

Despite these limitations, BMI is recommended by anthropologists and physicians for use in screening tests to pre-assess a child’s level of overweightness or obesity. An example of this can be found in the usage of growth charts in many European countries and the US for the evaluation of the discussed phenomenon in the progressive development of girls and boys [15-18]. Still, the issue of the normal and pathological boundary in this period of ontogenesis is not solved.

It is most commonly believed that it is marked by a transition above or below the broad development standard, located between the 3rd and 97th centile [19-21] or the 5th and 95th centile [22, 23]. However, there are proposals to use a narrow standard for this purpose, which is between the 15th and 85th centile [11] or the 25th and 75th centile [24]. The use of one or the other criterion depends on the type of the child’s body fatness [11].

Views on this subject are more clear in the case of adults. On the basis of analysis of world literature discussing the relationship between BMI and mortality, it has been established [25, 26] that there is a parabolic relationship, the apex (function optimum = lowest mortality rate) of which changes with age. It is ranged between 21.4 kg/m² at the age of 20-29 and 26.8 kg/m² in the 60-69 age group. Therefore, its excessively low or high level is not desirable. Taking into account other criterion of BMI evaluation, different zones of optimal influence on health are given. According to American views [27], it can be found between 19-24 kg/m² in women and 20-25 kg/m² in men. Therefore, it is assumed that 1° obesity occurs between 25-29.9 kg/m², 2° between 30-40 kg/m² and 3° above 40 kg/m².

As is clear from the above, the relationship between health indicators and BMI (and also indirectly FM) is not linear. From the analysis of previous research results, it can be concluded that the subject of deliberations is only concerned with BMI and mortality. According to American views [28, 29, 30], the zone of negative regressive influence and the negation of the zone of negative progressive influence connected with the increase of the indicator to the optimum zone influence. It seems that this is an equivalent problem considering the previously discussed criterion of death at different ages [25, 26], or in children and adolescents, the problem of biological development. Consequently, it seems that the issue of too little fat and BMI connected to the second pole of the parabola is noteworthy. Although such a phenomenon is less common than being overweight or obese, undesirable effects of malnutrition or diseases do not affect only the residents of highly developed countries. The issue of extremely low levels of fat in the body of children and adolescents is associated with a more and more frequently occurring disease known as anorexia nervosa.

Osteoporosis, bone loss, fracture tendency, muscle atrophy, cardiac arrhythmia, sudden death, swelling and reproductive disorders can be noted in individuals from the low fatness zone (Osinski [14], Mazess et al., [30]). In children, a certain level of fatness determines the onset of puberty. This is a particularly important issue for girls. Adipose tissue is the site of androgen transformation into estrogen and estrogen into estradiol. A young person with very low body fat may be at risk of lowered normal levels of estrogen, leading to inhibition of hypothalamic-pituitary-ovarian function and, consequently, delayed onset of the first menstrual period [31].

It is recommended that body mass and fatness be maintained at the so-called healthy level at all ages. According to a recent study [32], it is important to assume that 17% of body fat is needed to maintain a normal menstrual cycle, and until the first menstrual period, as much as 22% of body fat is needed. The correlation between the level of fatness, including BMI, and maturation rate are confirmed by Polish and international studies, but in boys it is not as pronounced as in females [33, 11, 34-37, 9].
Therefore, there is no reason to increase fat tissue growth too much (although with adult age this tendency is objective – Wilmore [38], Heyward [39]), nor reduce it beyond the boundaries of “optimal impact”.

Interestingly enough, according to American sources, the lower limit for men is 3-5% of body fat. Such a norm is also recommended for girls before puberty [40]. The problem of obesity in women was discussed earlier. It should be noted that previous American recommendations [40] provided various limits – norms necessary for their body to function (11-14%).

So far, the issue of the relationships between somatic features, including anthropometric indicators and motor features, has not been solved. To date, only well-documented and properly methodically conducted Polish study by Osiński [28] shows that there is an indefinite number of curves describing their forms. This also applies to the relationship between motor performance and BMI as well as fat mass. Most often, the relationships are characteristic of a parabola or curve that is closely related to it [28]. The relationship between features are more often defined than correlational relationships, studied by comparing the effects of their coexistence at different periods of ontogeny. Thus, on the basis of materials collected in the Krakow metropolitan population (Gołąb 2004), it has been demonstrated, among others, that the level of development of a specific motor feature is more influenced by the mass-height index than by body mass. Within the five groups distinguished according to centile ranking (1-20, 21-40, 41-60, 61-80, 81-100), there were also distinct differences in motor ability levels at three main periods of ontogenesis (age 8, 14, 19-20) and between centile ranges. In all the examined cases, greater differences were observed in the male subjects than the females.

The most favourable relationships among the features were noted when their rank was between the 41st-60th and 61st-80th centile. The exception was the variability in the medical ball scoring measurement, in which beneficial effects of the high BMI and fat mass levels were observed.

To a great extent, the described trends in the coexistence of positive indices (fitness and efficiency) in the extreme ranges of the growth chart of BMI can be seen in studies conducted in Polish rural populations [9]. In them (especially in boys), attention is paid to the already signalled negative impact of high (over the 75th centile) and low (below the 25th centile) levels of BMI and fat mass. This phenomenon was even more pronounced in the case of including the BMI index rather than fatness.

The results of these reports have encouraged attempts to confirm the signalled trends in other populations. Justification for such a decision can be found in the results of Osiński’s research penetration [28, 14]. The evidence gathered in it allows us to think that “(...) the processes of organic relationships and interdependencies that occur within the structure and function of the system can – even in individuals of the same age and characterized by identical values of morphological parameters (body mass and size as well as skin-fatty folds) – occur at different levels of phenomena depending on the characteristics of the environment from which the individual (the population) comes” [14, p. 119].

In light of the research achievements regarding somatic determinants of motor capacity and fitness to date, it is also interesting to see the structure of physical fitness examined in the convention of health and to determine the strength of correlations between body mass indices (indirectly measuring fat level) and motor and physical fitness tests in groups of individuals with low and high fatness levels.

In this report, we present the results of research conducted among girls from the Małopolska region, which aimed to:

1. Confirm the negative impact of high and low levels of fatness on positive health indicators of girls from Małopolska.
2. Understand the physical fitness structure studied in the convention of health as well as the strength and direction of the relationship between BMI and motor efficiency and physical fitness (positive health indicators in girls) in groups with high and low fat levels comprised of girls at three major periods of ontogenesis.

Material and methodology

The participants were female students being 1 – at a younger school age (at the “perfect child” stage), 2 – at puberty, 3 – at the adolescent developmental stage [41]. For this purpose, the data from the previous study [42] were used. From these participants, girls aged 9, 10, 13 and 14, 17 and 18 were chosen. After their summation, three groups corresponding to the above-signalled developmental periods were obtained. This regrouping was needed to obtain an appropriate number of groups, which were formed by the further division of the aforementioned groups in the predicted statistical analysis. The studied girls attended primary and secondary schools and lived in the towns and villages of the Małopolska, Świętokrzyskie and Połkarpackie regions. As a result, data regarding more than 3,200 individuals were used (see Table 1). The classification criteria for the three selected groups of girls was calendar age: for example, girls aged 13 and 6 months to 14 and 5 months were included in the group of 14-year-olds.
The results of measurements of basic somatic features, morpho-functional indicators and motor skills were taken into consideration in the study.

- BH – Body height
- BM – Body mass
  Four mass-height indicators were calculated from the above-given data [43]:
  - BMI – Body mass index,
  - ROHR – Rohrer index,
  - PI – Ponderal index,
  - QI – Quetelet index,
- Σ TS – Sum of two skinfolds (triceps and subscapular) [44],
- PF – Percentage of fat (Calculations were based on the Slaughter et al. [45] skinfold prediction equations),
- FM – Fat mass,
- LBM – Lean body mass (the difference between overall body mass and FAT mass calculated from percentage of fat content in body mass),
- Flex – Flexibility (Eurofit test) [46],
- VO₂ max/kg – Max. oxygen consumption. Januszewski’s modification [47] of the Margaria et al. test [48] was used,
- JUMP – Standing broad jump. Test according to Eurofit [46] evaluating the dynamic power of the lower limb muscle contractions,
- THROW – Over-head 2 kg medicine ball throw. Test evaluating the dynamic power of the upper limb and trunk muscle contractions,
- R50 – Standing start 50 m – run (running speed),
- R1000 – Running time for 1,000 m – run. Trial evaluating running endurance in accordance with the game called "Punctual train", (running 10 times along a square with a 25 cm side) [49],
- SO – Spatial orientation. Time to perform 49 tasks in the "free" series on the AKN 102 visual-motor tester.

For all morphodynamic variables and motor abilities of the studied girls – aged 9-10, 13-14 and 17-18 – basic statistical characteristics, i.e. arithmetic mean (Me), standard deviations (SD) and variability indicators (V) were calculated. The data are given in Table 2.

Then, the above-mentioned populations were divided into seven groups. The criteria for this division were the means and the dispersion measurements of the mass-height index – BMI, which gave rise to the following groups of girls:

- F – fairly thin   BMI < Me – 1.5 SD
- E – thin   BMI < Me – 1.0 to – 1.5 SD
- D – averagely underweight  BMI < Me – 0.5 to – 1.0 SD
- BMI = Me ± 0.5 SD
- A – overweight  BMI > Me + 0.5 to 1.0 SD
- B – slightly obese  BMI > Me + 0.5 to 1.0 SD
- C – significantly obese BMI > Me + 1.5 SD

The number of participants in the groups is shown in Table 1. The review of these data show that there is asymmetry in the proportions of cumulative values between those obese and the slim subjects, in favour of the latter. High lability of percentage rates in selected fractions from A to F showed more girls with significant obesity (7.33%) than those exceptionally slim (3.10%). The occurrence of such a phenomenon is confirmed by observations noted so far [9].

For the selected fractions A, B and C and D, E and F, Me and SD were calculated. This enabled normalization of mean arithmetic morphological and functional as well as fitness variables in the 9-10, 13-14 and 17-18 age groups to 0 and 1 (i.e. the mean and standard deviation of girls enrolled in groups with mean values taken into account for somatic and motor skills).

In the case that there were doubts regarding normality of distribution of the considered measurements, their logarithmization was performed. As it can be concluded from Tab. 2, the following variable values were logarithmized [50]: Σ TS, PF and FM, as well as the results of the medicine ball throw and spatial coordination. In the extreme B and C as well as E and F groups, correlational

<table>
<thead>
<tr>
<th>Table 1. The number and percentage participation of the tested girls in particular age groups and in groups differentiated by BMI value</th>
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<tr>
<td>Group</td>
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<td>Age</td>
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<td>13 - 14</td>
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<td>17 – 18</td>
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<tr>
<td>Total</td>
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<td>%</td>
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</table>
matrices on the basis of raw and logarithmized values were calculated in the case of 50 studied girls.

Additionally, cluster analysis was conducted on the above-mentioned correlation matrices. In order to distinguish homologous sets of the studied features – in the extreme groups of girls at different stages of development – Ward’s taxonomic method was used [51, 52]. Differences in arithmetic means and correlation coefficients were considered statistically significant at a level of at least 5% (p < 0.05).

Results

From the analysis of the materials presented in Table 2, it is clear that the age-related variability of basic somatic features, mass-height indicators, subcutaneous fat mass and lean body mass (LBM) in the examined girls groups indicates (as expected) a consistent characteristic increase in the values of arithmetic means, which is consistent with the general development trend, most often occurring in metropolitan populations.

However, the value of the Quetelet II – BMI index, which plays the role of one of the independent variables in this report, deserves special emphasis. In the available literature related to this quotient – determining the body mass index (in kg) to squared body height (in m²) - it can be stated that it is "(...) the simplest and most valuable indicator in evaluating body structure as an element of H-RF" [53], and in this respect (in addition to: musculoskeletal, motor, circulatory-respiratory and metabolic abilities), it is included in morphological efficiency. Its value is most often determined for adults [e.g. 14, p. 273]. It results from the fact that for mature women, it is, as already mentioned in the ‘Introduction’, a desirable value ranging from 19 to 24 kg/m², which should determine the longest survival time. In our study, the BMI (as well as the somatic features mentioned above) also indicates a steady increase with age for those who are average. The calculated standards (within the limits of Me ± SD) assume the following values: for the youngest group (9-10 girls) this range is 14.0-18.8 and for the other groups 16.3-21.7 and 18.6-23.1 kg/m².

Based on the scores from the T scale [42], the arithmetic means of the Quetelet II coefficient reach 41 (32-50), 51 (40-61) and 58 (49-67) pts., respectively.

With age, the progression of the results obtained in subsequent fitness tests is also consistent with developmental rights, including average data regarding flexibility (Tab. 2). The arithmetic means of maximum oxygen consumption per kilogram of body mass act slightly differently over time. They do not show substantial changes over the years, as evidenced by the commonly known phenomenon that the relativised magnitude of VO₂max – in the progressive period of personal development – does not change [54-57].

Table 2. Basic statistical data of selected morphofunctional and motor parameters of the tested girls

<table>
<thead>
<tr>
<th>Parameters</th>
<th>9-10 years (n=1052)</th>
<th>13-14 years (n=1605)</th>
<th>17-18 years (n=564)</th>
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<tbody>
<tr>
<td></td>
<td>Me</td>
<td>SD</td>
<td>V</td>
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<tr>
<td>BH (cm)</td>
<td>134.92</td>
<td>7.30</td>
<td>5.41</td>
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<tr>
<td>BM (kg)</td>
<td>31.63</td>
<td>6.28</td>
<td>19.85</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>16.41</td>
<td>2.42</td>
<td>14.75</td>
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<tr>
<td>ROHR (g/cm³)</td>
<td>1.22</td>
<td>0.17</td>
<td>13.93</td>
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<tr>
<td>PI (cm/√kg)</td>
<td>43.65</td>
<td>1.99</td>
<td>4.56</td>
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<tr>
<td>QI (g/cm)</td>
<td>221.85</td>
<td>38.03</td>
<td>17.14</td>
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<tr>
<td>Σ TS (mm)</td>
<td>17.61</td>
<td>7.91</td>
<td>44.92</td>
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<tr>
<td>PF (%)</td>
<td>16.16</td>
<td>6.04</td>
<td>37.38</td>
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<tr>
<td>FM (kg)</td>
<td>5.11</td>
<td>2.97</td>
<td>58.12</td>
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<tr>
<td>LBM (kg)</td>
<td>24.97</td>
<td>4.08</td>
<td>16.34</td>
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<tr>
<td>FLEX (cm)</td>
<td>54.10</td>
<td>5.61</td>
<td>10.37</td>
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<tr>
<td>VO₂ max/kg/ml</td>
<td>46.53</td>
<td>8.56</td>
<td>18.4</td>
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<tr>
<td>JUMP (cm)</td>
<td>129.88</td>
<td>19.84</td>
<td>15.28</td>
</tr>
<tr>
<td>R50 (s)</td>
<td>3.54</td>
<td>1.07</td>
<td>30.23</td>
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<tr>
<td>R1000 (s)</td>
<td>381.85</td>
<td>53.11</td>
<td>13.91</td>
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<tr>
<td>SO</td>
<td>130.64</td>
<td>41.81</td>
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In a publication presenting the value of the analytical physical fitness test — Eurofit [46, p. 8], it is said that with its usage "... individual or group health losses can be revealed" due to the decrease in the exercise capacity (especially strength) of the studied children. It is useful as indicators for finding the cause of this state of affairs and in specifying "(...) the basis for estimating and allocating possible therapeutic measures". Hence, it is suggested that in addition to motor abilities, the test should also assess morphological, musculoskeletal and cardiopulmonary functions.

Following the above-mentioned trail of reasoning, we wanted to see if the BMI values [14] – can actually have negative influence on the results of the above-mentioned abilities. For this purpose, we calculated the normalized data of the analyzed variables to the arithmetic mean (0) and standard deviation (1) of the groups of girls with an average BMI (ages 9-10, 13-14 and 17-18) for six groups. The results of such codified data and their comparison are illustrated in Figures 1 and 2 and Table 3a, 3b, where basic statistics are used to calculate the variation in variables of particular interest. They concern flex-

<table>
<thead>
<tr>
<th>Table 3a. Basic statistical data of selected morphofunctional of the tested girls in age groups and in groups differentiated by BMI value</th>
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<td><strong>BMI</strong></td>
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Commentary – see Methods and Research Files
Table 3b. Basic statistical data of flexibility, VO₂ max/kg and selected motor parameters of the tested girls in age groups and in groups differentiated by BMI value

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</table>

Commentary – see Methods and Research Files
In this age group, the decrease in BMI data does not affect the result of the 50 m run. The statistically significant worsening of the result for this distance was only found among the girls in group F, but only for the ages 9-10 and 13-14.

The smallest deviations (statistically non-significant) from the profile axes (among students with average BMI) are shown by the data of the overweight (A) and underweight (D) groups, and the largest – statistically significant – C (with significant obesity) and F (significantly slim), which may indicate that BMI actually does correctly evaluate morphological fitness, while simultaneously evaluating the suitability of this indicator in assessing physical development as well as vital strength in the form of health-oriented motor abilities, in the context of the H-RF concept [14].

The obtained numerical figures presented in Table 4 confirm the suggestion resulting from the analysis of
profiles (Fig. 1) regarding the mutual dependence of BMI and body build variables as well as selected motor abilities. The analysis of data in this table shows that the mass-height index is related to body mass with three similar quotients (Rohrer, slimness and Quetelet indices) irrespective of the age of the examined girls and their division into “slim” (E+F) and “obese” (B+C) groups. Thus, the results of research by e.g. Chrzanowska, concerning, among others, the relationship between body mass and mass-height indicators, [11, p. 50] are indirectly confirmed.

However, the Quetelet II index is not linked to body height, with the exception of the 9-10-year-old B+C students. Furthermore, the analysed coefficient does not correlate with the parameters of subcutaneous fat (Σ TS, PF and FM) in the “slim” groups aged 9-10 and 17-18, as opposed to those in the pubertal development phase (i.e. age 13-14). This may indicate that, at this time, the decrease in BMI in the “slim” girls takes place without significant loss of adipose tissue needed to achieve puberty. An extremely consistent image emerges when comparing the average age of secondary gender characteristics and the menarche age in the report by the above mentioned author [11, p. 50] emphasizing that: “(...) the higher the level of fat, the lower the average age of puberty; this applies to all stages of development of breasts and pubic hair both in girls and boys”. In addition, the relationship of BMI with LBM faded in individuals in the “obese” groups of 13-14 and 17-18-year-olds, suggesting that the increase in body mass index during these developmental periods was at the expense of lean body mass.

The relationship of BMI with flexibility, VO₂ max/kg and selected motor abilities is very different. Few exceptions show the inverse proportional relationship of BMI with relative oxygen consumption in the youngest and oldest age groups (B+C groups of girls) and the average for flexibility, as well as girls from the 9-10-year-old E+F – with spatial orientation. These cases partially confirm the negative direction of deviation of the curves from the axis both in the case of students with excess body mass and with too much of its loss, which in turn, negatively affects the development of the concerned motor skills.

The applied cluster analysis¹ using the Ward method [51] gave insight into the structure of specified sets of variables (see Figure 3). Valuable information is also provided by the “full taxonomic tree” indicating which clusters combine with the considered parameters at following levels.

The emerged – with the use of the aforementioned method – number of sets at the height of the “boughs” of the “tree” does not change, both in the selected age groups or in their “slim” and “obese” subgroups. They do not exceed 40 units of the cluster factor. Only a weak set consisting of body height, long jump result and Quetelet index, and the result of the 1,000 m run connected to it (at the same

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¹ In the work, the term “cluster” is used interchangeably with “set”, “group”, “range”, “component”.

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Table 4. Linear correlation coefficients between BMI indices and selected morphofunctional and motor parameters in 3 age groups with division into groups: slight obesity (B), notable obesity (C), slim (E), notable slimness (F)

<table>
<thead>
<tr>
<th>Age</th>
<th>9-10 years</th>
<th>13-14 years</th>
<th>17-18 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>B+C</td>
<td>E+F</td>
<td>B+C</td>
</tr>
<tr>
<td>BH</td>
<td>0.39</td>
<td>-0.19</td>
<td>0.07</td>
</tr>
<tr>
<td>BM</td>
<td>0.83</td>
<td>0.42</td>
<td>0.71</td>
</tr>
<tr>
<td>ROHR</td>
<td>0.85</td>
<td>0.81</td>
<td>0.87</td>
</tr>
<tr>
<td>PI</td>
<td>-0.84</td>
<td>-0.83</td>
<td>-0.86</td>
</tr>
<tr>
<td>QI</td>
<td>0.93</td>
<td>0.74</td>
<td>0.89</td>
</tr>
<tr>
<td>Σ TS (log)</td>
<td>0.45</td>
<td>0.08</td>
<td>0.60</td>
</tr>
<tr>
<td>PF (log)</td>
<td>0.44</td>
<td>0.11</td>
<td>0.59</td>
</tr>
<tr>
<td>FM (log)</td>
<td>0.67</td>
<td>0.24</td>
<td>0.70</td>
</tr>
<tr>
<td>LBM</td>
<td>0.61</td>
<td>0.37</td>
<td>0.08</td>
</tr>
<tr>
<td>FLEX</td>
<td>-0.01</td>
<td>0.20</td>
<td>-0.28</td>
</tr>
<tr>
<td>VO₂ max/kg</td>
<td>-0.35</td>
<td>0.12</td>
<td>-0.05</td>
</tr>
<tr>
<td>JUMP</td>
<td>-0.10</td>
<td>0.00</td>
<td>-0.04</td>
</tr>
<tr>
<td>THROW (log)</td>
<td>0.12</td>
<td>0.09</td>
<td>0.04</td>
</tr>
<tr>
<td>R50</td>
<td>0.10</td>
<td>-0.03</td>
<td>0.23</td>
</tr>
<tr>
<td>R1000</td>
<td>0.22</td>
<td>-0.02</td>
<td>0.19</td>
</tr>
<tr>
<td>SO (log)</td>
<td>-0.06</td>
<td>-0.39</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Commentary – see Methods and Research Files
Further diversification of the “components” takes place at the upper levels (i.e., the “branches” and “twigs”) of the said “tree” at parallelly decreasing gaps of metric spacing. For example, in obese students, the result of the 1 km run is connected with the WQ mass-height index at a distance just over 10 Euclidean units, while simultaneously changing the “clustering” sequence order to fourth place. However, this set (in the group of individuals who are maturing and who are at the adolescent development period) occupies second place.

The very strong third component can be found at the highest level of the “taxonomic tree” reaching the end of its “twigs” (i.e., zero in metric distances). This set consists of six major variables: the Rohrer index and the logarithmized values of the subcutaneous adipose tissues (Σ TS, PF and FM), and the similarly converted values of the spatial orientation and medicine ball throw tests. This set is present in all the selected groups of girls. In this component, only single changes in occurrence order were noted for the last two of the aforementioned objects among the confronted groups: “thin” and “obese”. Furthermore, at the height of a few Euclidean units of the discussed cluster, it is complemented by BMI and 50 m running time in the “slim” group, while for the “obese” individuals, this is the case only for the results of shorter distances. Among the 9-10-year-old “slim” pupils, body mass and LBM are additionally added to the group. The slightly weaker fourth group (aged 13-14 and 17-18, both among the “slim” and “obese” pupils) is comprised of body mass, PI, LBM, VO2max/kg, and flexibility with few switches in individual features. In groups of “obese” girls (in all age groups), the BMI is additionally added to the set, and in the youngest group, this component occupies the third position. Among the “slim” pupils aged 9-10, this set consists only of three variables (FLEX, VO2max/kg and PI). In any case, the beginning of this set begins at the level of the “branch of the taxonomic tree” at a distance of about 20 units in metric space.

The results of analysis using the Ward method do not confirm significant differences between groups, both in age groups or individual groups characterized by a variable BMI value. Therefore, it can be concluded that the image of the confronted range structures (especially in 13-14 and 17-18 age groups) is very similar. Minor differences only emerged in the youngest age group of “slim” and “obese” girls in the sequence of sets, changes in the number of variables within them and in slightly different spatial distances for “boughs, branches and twigs of the taxonomic tree”.

The above considerations concerning the influence of body structure on the motor efficiency of children and adolescents in the aspect of Health-Related Fitness [53] (i.e., oriented on exercise-based health multiplication) can be summarized by the very accurate opinion of an author [59] stating that “... the age of initiation of the...
pre-puberty increase in adipose tissue growth may be considered as an indicator of the subsequent development of obesity, and as early as in childhood, observing relative body mass expressed by BMI and appropriately early prevention can be very important in the prophylaxis of obesity in adulthood”.

The quoted opinion (also for the sake of proper development) should refer to our observations on underweight girls, and even more so on “slim” and “significantly slim” individuals.

**Summary and conclusions**

The analysis of materials collected in the population of Małopolska region girls allowed to draw attention to the negative impact of low and high values of the BMI (the indirect indicator of fatness measurement) on the development of the fitness and motor skills of girls from Małopolska. While the issue of relationships and co-occurrence of being overweight, obese and positive health measures is often undertaken in foreign and Polish scientific work, the second problem (the role of low body mass), undertaken in our own research, is rather treated marginally by researchers. The situation of malnutrition is not typical of developed countries. Poverty, the main factor for this phenomenon, is most often the effect of economic decline, cataclysms or wars. Recently, such phenomena has bypassed highly developed economies. And it is their residents who are concerned not only with the creators of social policy, but also with the creators of the research strategy. Lack of interest in underweight or malnourished children may be justified by the disappearance of social gradients and secular trends in some countries [60, 61]. In such prosperous countries as the United States of America, Norway or Sweden, the problem of being underweight is primarily connected with the disease phenomenon to which the problem of anorexia is undoubtedly related.

In addition to the fact that research is dominated by the negative effects of obesity and being overweight, currently studied in a variety of ways [2, 62], it is worth pointing out that it mainly concerns fully mature people who have completed their adolescence period. Nothing unusual. As is evident from earlier publications in many countries including Poland, the phenomenon of child and adolescent fatness, although growing, there are no epidemiological signs. For many years, such features have evolved into the phenomenon of being overweight or obese in the countries of prosperity in older individuals [63].

It seems that omission, of these issues in scientific research, not only in our country, is not justified. Social and biological considerations are at stake. Apart from the very complex phenomenon of Polish poverty [64-66], which is often felt more psychologically than physically, the existence of documented social inequality in the manifestations of somatic and motor development in children and adolescents should not be overlooked [67, 61, 68]. Moreover, in light of the results of comparative studies presented in the research conducted at the end of the 20th century by the Mother and Child Institute in Warsaw [69] and in the “Cracow Health Report” [70], the incidence of underweightness is sometimes even more pronounced than being obese. The interpretation of the issue should take the age, sex and place of residence of children and adolescents into account. According to nationwide research [69], being underweight is more prevalent among boys, especially in younger age groups and in rural areas. It is interesting that, according to the aforementioned materials, 7-17-year-olds in Polish villages were less frequently obese than underweight, and the relationships between being underweight and overweight were similar (within 3-4%). Another situation was found in urban areas. At slightly lower percentages of underweightness (below 3%) and higher in obesity (3-4%), the number of overweight children and adolescents was twice as high as in rural areas (5-6%). A similar situation was found in our own research. At the average age of 9-18, 3.1% of boys were slim and 7.73% of them were overweight. From the Cracow Report, it can be deduced that the number of obese children increased rapidly only in secondary schools. At the age of 7-15, the phenomenon of obesity and being overweight was at a very similar level among the young inhabitants of Krakow. In the youngest 7-8-year-old age groups, even more girls (4.1%) and boys (3.8%) were underweight than obese (1.8% boys and 1.3% girls). The described growth phenomenon along with the age of the overweight individuals was not revealed in our research. One could even notice a slight decrease in the percentage of the phenomenon in question and an increase in the number of slim girls.

It seems that not only for cognitive but, above all, applicative purposes, the issue of the influence of both extremes of the scale of variation in body build index on positive health indicators should be solved in scientific research. Exposing only one side of the variability scale seems to be controversial, although for social reasons (the increase in the phenomenon) and also prestige (fashion for such research in numerous European and American countries), can be understood. As earlier noted, a review of Polish literature shows that disproportions in favour of the development of issues related to being overweight and obese are very clear.

Therefore, the results of our own research do not have many reference points. These can be found in the materials, among others, published in recent years by Goląb [71] and Poplawska [9]. It should be stressed, however, that the problem of being underweight is not highlighted.
It is only a background for solving other issues. Also in foreign literature, very rarely (probably for the aforementioned reasons) is the impact of the phenomenon on the level of positive health measures taken into account, which undoubtedly includes the features of body build or motor efficiency. Among them, we may find a Belgian study on the level of somatic and motor development of children and adolescents at four major stages of progressive development: age 12, 14, 16, 18, from the extreme ranges of fatness indices (5th and 95th centile). Materials collected in these studies have shown that although the obese subjects were taller and bigger, they obtained an advantage over the slim individuals only in the case of strength and flexibility measurements [72, 73].

The results of our research, as well as the studies by Golab [71] and Poplawksa [9], do not confirm such unequivocal statements. Perhaps environmental differences occurred in the discussed problem. It is impossible to exclude the effects of different approaches to the assessment of fatness, although the results of the study by Nawarycza et al. [2] that “BF values, assessed using the BFimp electro-impedance method and BFclp caliper show a significant correlation with BMI”. This is confirmed by previous reports [74, 45, 11] stating that BMI is useful for initial assessment of overweightness and obesity. The median value and distance of the extreme centiles from it could have also affected the variation in the results. After all, the distribution of results is marked by inter-population differences. It is difficult to compare the value of the 5th and 95th centile in different studies on individuals of the same sex and from the same age groups.

From the collected materials, it can be concluded (as previously noted) that both high and low BMI levels negatively affect most components of motor efficiency, flexibility and exercise capacity. Only the measurements of the strength of the upper parts of the upper limb muscles, examined by the medical ball throw test, were an exception from such a rule. In this case, similarly as in the Belgian and Polish studies (i.e. the earlier mentioned study by Szopa [58]), we noticed coexistence of somatic features as well as correlational relationships between them. At some stages of ontogenesis, large connections between the Quetelet II index and body composition parameters (with the exception of body height and the relationship between BMI and flexibility as well as body mass components) can be found in groups with individuals characterized by high and low BMI. This clearly speaks for the fact that BMI properly evaluates the state of morphological efficiency while confirming its usefulness in the evaluation of physical development as well as vital forces in the form of motor-oriented health as part of the H-RF concept [53]. Cluster analysis using the Ward method additionally confirmed that in the case of low and high BMI of the studied girls, there was a similar structure of the connections between features. It follows that the structure of physical fitness (and more broadly in the H-RF convention, positive health indicators as well) is similar in slim and obese individuals.

Taking all the above into consideration, it seems that our deliberations can be completed with the following general observations:

- The research conducted in the group of girls from Malopolska confirm the existence of:
  1. The negative effects of excessive and low levels of fat on the level of positive health indicators,
  2. Statistically significant correlations only between BMI and somatic features measuring body fatness,
  3. The weak relationship between BMI level and gauges of positive health such as physical fitness and motor skills,
  4. A similar structure of physical fitness examined in the convention of health in groups with lower and higher levels of fat.

References


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BREAKING GENDER STEREOTYPES: 
THE RELATIONSHIPS BETWEEN PSYCHOLOGICAL GENDER, PERSONALITY AND THE SYSTEM OF VALUES IN THE CASE OF FEMALE FIELD HOCKEY PLAYERS

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Keywords: psychological gender; female athletes; values; personality

Abstract

Aim: The aim of the study was to determine the predictors of female sports success by examining the relations between psychological gender on the one side, and personality as well as the system of values on the other in the case of female field hockey players. An attempt was made to demonstrate what the dominant psychological gender of the athletes under the study was, while it had been assumed that it would be the androgynic type.

Basic procedures: The research was conducted among field hockey players of the Polish National Team. The average age was 21.4 years.

Results Main findings: The present research did not confirm the dominance of masculine or androgynic types among the female field hockey players under study. Therefore, personality type was related to the system of values, and psychological gender was a factor moderating the preferred values. In the case of androgynic types under study, the dimension of Openness was connected with the decrease of importance of True Friendship and Agreeableness with an increase in the Forgiveness value. Androgynic athletes were more oriented on terminal personal values, while feminine ones were oriented towards social goals.

Conclusions: Feminine athletes were characterized by a lower level of extraversion than androgynic and undifferentiated subjects.

Introduction

A stereotypical outlook on female traits is in contradiction to the socially expected traits of a sports person. Sports activity requires an individual to be goal-oriented, aggressive, individual, strong, i.e. possess traits allegedly ascribed to men. Women doing sports are typically associated with such disciplines as dancing, gymnastics, volleyball. Currently, however, women are as likely as men to take up a whole range of physical and sports activities (despite the previously held stereotypical beliefs that men are more active in this respect) [1].

In spite of the abovementioned trend, the dichotomous perception of sports as divided into feminine and masculine is still observed. While some studies suggest [2] that girls feel weaker and less competent in sports than boys,
it should be recalled that women are sometimes either discouraged or banned from doing sports on social, cultural or religious bases [3].

Entirely disparate features are ascribed to men and women within a classic approach to the dichotomy of gender-related roles. Formulating stereotypes connected with gender is influenced by particular components of the stereotype – the presence of one component impacts the remaining ones. As an opposition to this classic biological perspective, Sandra Bem’s theory of psychological gender has emerged. According to the author, the traditional “femininity – masculinity” division is an effect of cultural influences and social expectations. It is, therefore, reasonable to consider not only the biological gender of a given individual, but also the existing social conditions. These encompass: social roles, the way of expressing emotions or kinds of sexual experiences. Bem has listed four psychological types of gender: male or female sex-typed, combined cross-sex-typed (masculine women, feminine men), androgynous (a considerable number of traits combining femininity and masculinity), and sexually undifferentiated (a low concentration of either feminine or masculine traits) [4,5]. A great role in the formulation of particular gender-related stereotypes is assigned to parents in the process of socialization [6].

What the current research on the psychological gender of women doing sports has proven so far is that androgynous and male types are dominant amongst sportswomen if compared with women not doing any sports. The comparison of how sportswomen and non-sportswomen deal with fulfilling masculine and feminine roles has proven, on the other hand, that they are to a greater extent capable of adjusting themselves to male standards assigned to sports performance [7].

Women doing sports debunks the belief that they are weaker, worse, less professional or that sport itself is dominated by men (which was a corollary of the stereotypical perception of men’s cultural dominance). It is also not always true that sports challenges undertaken by women are less demanding than those undertaken by men [8].

A subsequent (after psychological gender) aspect analyzed in the present report is the Five-Factor Model of personality. Costa and McCrae enumerated the following factors contributing to the shape of personality: Neuroticism (connected to tension, depression, frustration, irrational thinking, sense of guilt, low self-respect, weak control over impulses, ineffective stress management, somatic conditions), Extraversion (linked to the tendency to take risks, socializing, talkativeness, energy, ambition), Agreeableness (linked to such traits as altruism, social support, friendliness), Openness to experience (connected with curiosity, originality, imagination, broad-mindedness, artistic activity) and Conscientiousness (related to ambition) [9].

There have been attempts to track down the relationship between such variables as sex, cultural factors or age and the traits the Big Five comprises. As suggested by the research quoted by Schmitt et al. [10], the personality variables distinguished by Costa and McCrae reach different values in the cases of women and men surveyed by the Big Five Questionnaire. Women turn out to be more neurotic, extravert, agreeable and conscientious than men. In order to formulate such unambiguous conclusions about personality and gender, however, cultural differences need to be taken into consideration. For it is possible that in addition to the Big Five factors, other ones might be distinguished, which are specific to a particular culture.

Gordon [11] defined values as constructs representing behaviours and mental states significant from the point of view of an individual and stated that, despite the possibility of them being altered, values exhibit a tendency to remain unchanged despite the passage of time. According to Lachman at al [12], major (unchangeable) and peripheral (modifiable) values can be distinguished. Simultaneously, the moral value hierarchy an individual subscribes to determines the choice of decisions made. Values are not disparate components of personality but create hierarchical systems in various combinations. Thanks to this it can be stated that certain values are more important to an individual than others and, as a consequence, influence the psychological life of a person (perception, thinking, emotional-motivational processes, attitudes) as well as their behaviour to a greater extent than values which are less important. Rokeach [13] defined a value system as an „enduring organization of beliefs concerning preferable modes of conduct or end-states of existence along a continuum of relative importance” (p. 5).

Two types of values may be distinguished: terminal values and instrumental values. The former point to the goals people strive after, the latter refer to the behaviour and personality traits enabling the goals to be reached. Amongst instrumental values, Rokeach [13] listed moral values (e.g. love, honesty) and competency ones (e.g. ambition, creative imagination), while amongst terminal values: personal values (e.g. salvation, inner harmony) and social ones (e.g. a world at peace). Although a great diversification between individual values and systems of goals exists, a plausible range of variability of value hierarchies within a given culture group can be predicted [13]. This defined range results from socialization processes common for a particular culture. Feather [14] stated that value systems evolve with age.

It has been suggested that a value system influences lifestyle [15]. What is required to be added is that Rokeach [13] indicated that a given behaviour is the consequence of a compromise between opposing values, which at the same time, are connected with this particular behaviour. Research has suggested gender diversi-
Breaking gender stereotypes: the relationships between psychological gender, personality and values

In spite of these disparities, it can be observed that differences between genders are more easily perceivable in Western cultures than in Asia [18], which may seem surprising bearing in mind all the efforts to equate males and females observed in the Western world. If, however, one considers the aspect of individualism vs. collectivism in the abovementioned cultures, it can be observed that in collectivist cultures, to which Asian cultures belong, less attention is paid to social comparison, which in turn leads to intergender differences being less emphasized [19].

Several differences between personality and values can be observed. Values contain an appraising element, which is not to be found in personality traits. They refer to what we think, while personality regards for what we think. Moreover, personality traits are relatively innate predispositions [21] while values are learnt, socially accepted beliefs necessary for adjusting one’s own needs to what is socially approved [22]. Values are also much more dynamic structures than personality traits, since they can be modified if an individual gets close to a different, new environment [13], while personality trait are relatively stable throughout one’s life [23, 24].

In spite of these disparities, it can be observed that certain terms may be used referring to values as well as personality traits [25, 26]. Values may mitigate behaviour resulting from expressing one’s personality since they refer to rules and principles regulating the functioning of a given society [21].

Parks carried out a meta-analysis of relationships between values and personality traits, although it should be stressed that the sample he used was rather small (11 surveys). In spite of this, it can be concluded that the two constructs are correlated. Openness to experiences and Agreeableness seem to have the strongest relatedness to values, Conscientiousness and Extraversion exhibit weaker relatedness, while the weakest relatedness can be found between values and Neuroticism [21].

Study aim

The aim of the study was to determine the relations between psychological gender, personality and a value system in the case of female field hockey players. It was assumed that the type of psychological gender may differentiate the preferred value hierarchy and moderate the relatedness between personality and the preferred value structure. It was also predicted that the majority of participants would be characterized by the androgynic type of psychological gender. Numerous studies have shown that amongst women professionally doing sports which are typically regarded as masculine, the predominant kind are females of androgynic or masculine type of psychological gender [1, 27, 28, 29, 30, 31].

Material and methods

The research was conducted amongst 19 female Polish National Field Hockey Team members. The average age was 21.42 ($SD = 4.49$).

In the present study, M. Rokeach’s theory of values (1973) and his Value Survey were used in order to determine and interpret the value systems of participants. The questionnaire allows to determine preferred structures of values – 18 terminal values and 18 instrumental ones. A participant lists the values giving them ranks from 1 to 18. The most important value for a given person was labeled 1, the least important – 18.

In this study, the Psychological Sex-Type Inventory IPP by A. Kuczynska [32] was also used. It consists of 35 items, 15 of which are ascribed to stereotypically female traits, 15 – to stereotypically male traits, while the remaining 5 are buffer questions. On a 5-rank scale, a subject determines to what extent a given trait refers to him/her. The results of masculinity and femininity scales allow to assign an individual to one of four types of psychological gender. The androgynic type are people who obtain high results on both femininity and masculinity scales. The sex-typed are males obtaining high results on the masculinity scale and low on the femininity scale, and females characterized with high results on the femininity scale and low on the masculinity scale. The cross-sex-typed are males with high results on the femininity scale and low on the masculinity scale, and females who get high results on the masculinity scale and low ones
on the femininity scale. Undifferentiated type relates to persons who obtain low results on both scales. 

Personality was measured with the Revised NEO Personality Inventory by Costa and MacCrae [33]. 

The study was conducted in Poland, within one day during the team assembly. Having completed the first questionnaire, each group was given a subsequent one and so on. Prior to distributing each test, the person in charge of conducting the research stressed that participants needed to get well-acquainted with the instructions printed on the first page of every questionnaire. Participants did not exceed the time limit. 

Before the beginning of the procedure, the whole group of participants was informed that the answers were anonymous. The participants were only asked to fill in their year of birth on the first page of each test, while the questionnaires themselves were coded, i.e. each person was assigned one number which was to be put down on the first page of every questionnaire. 

Calculations were done using the IBM SPSS Statistics 21 (SPSS Inc., Chicago, IL, USA) and Statistica 10 (StatSoft, Inc., Tulsa, OK, USA) statistical packages. Analyses were conducted with analysis of variance for repeated measures together with planned comparisons, one-way analysis of variance along with the Hochberg post-hoc test – GT2, and also moderation analysis (interactive analysis of regression) together with planned comparisons. A test comparing two components of the structure was conducted as well. 

**Results** 

Initially, the typology of psychological gender among the surveyed sportswomen was analyzed. It turned out that all types of psychological gender were observed. It was noted that 7 players (36.84 %) were of androgynic psychological gender and 7 players (36.84%) were feminine, while 3 (15.79 %) – undifferentiated type and 2 (10.53%) – masculine type,. The observed difference was not statistically significant. What this means is that in the group under study, the androgynic or masculine psychological gender was not predominant. 

Due to the necessity to conduct interactive analysis, analysis of variance for repeated measurements was used. Details of the results are presented in Tables 1 and 2. The higher numerical value, the lower place in the system of values. 

Statistically significant differences between the general hierarchy of instrumental values and psychological gender of the subjects was not observed ($F_{1,255} = 1.19; p = .19; \eta^2 = .19$), but it should be taken into consideration that the cardinality of the two of four groups was

<table>
<thead>
<tr>
<th>Terminal values</th>
<th>$M_{FT}$</th>
<th>$M_{AT}$</th>
<th>$M_{UT}$</th>
<th>$M_{MT}$</th>
<th>$M_{FT}$</th>
<th>$M_{AT}$</th>
<th>$M_{UT}$</th>
<th>$M_{MT}$</th>
<th>$p_{PP}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equality</td>
<td>6.71</td>
<td>11.86</td>
<td>8.67</td>
<td>5.50</td>
<td>4.15</td>
<td>3.44</td>
<td>4.04</td>
<td>2.12</td>
<td>FT vs. AT = .02</td>
</tr>
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<td>Freedom</td>
<td>7.43</td>
<td>6.86</td>
<td>7.67</td>
<td>14.00</td>
<td>3.95</td>
<td>2.67</td>
<td>1.53</td>
<td>4.24</td>
<td>AT vs. MT = .03</td>
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<td>National Security</td>
<td>8.86</td>
<td>14.86</td>
<td>8.67</td>
<td>12.50</td>
<td>3.72</td>
<td>4.67</td>
<td>8.33</td>
<td>4.95</td>
<td>FT vs. AT = .01</td>
</tr>
<tr>
<td>A World at Peace</td>
<td>9.57</td>
<td>13.00</td>
<td>6.00</td>
<td>12.00</td>
<td>4.89</td>
<td>6.27</td>
<td>7.81</td>
<td>2.83</td>
<td>AT vs. UT = .01</td>
</tr>
<tr>
<td>Inner Harmony</td>
<td>12.00</td>
<td>6.00</td>
<td>13.67</td>
<td>8.50</td>
<td>3.56</td>
<td>3.87</td>
<td>3.79</td>
<td>3.54</td>
<td>FT vs. AT = .01</td>
</tr>
</tbody>
</table>

**Table 1. Variance analysis of the relationship between psychological gender and terminal values**

<table>
<thead>
<tr>
<th>Instrumental values</th>
<th>$M_{FT}$</th>
<th>$M_{AT}$</th>
<th>$M_{UT}$</th>
<th>$M_{MT}$</th>
<th>$M_{FT}$</th>
<th>$M_{AT}$</th>
<th>$M_{UT}$</th>
<th>$M_{MT}$</th>
<th>$p_{PP}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honesty</td>
<td>5.14</td>
<td>7.11</td>
<td>1.67</td>
<td>7.00</td>
<td>3.24</td>
<td>4.92</td>
<td>1.15</td>
<td>4.24</td>
<td>AT vs. UT = .04</td>
</tr>
<tr>
<td>Courage</td>
<td>9.57</td>
<td>10.43</td>
<td>4.00</td>
<td>7.00</td>
<td>3.64</td>
<td>4.61</td>
<td>4.36</td>
<td>1.41</td>
<td>FT vs. UT = .03</td>
</tr>
<tr>
<td>Intellect</td>
<td>9.86</td>
<td>10.71</td>
<td>13.67</td>
<td>5.50</td>
<td>4.71</td>
<td>4.11</td>
<td>3.21</td>
<td>4.95</td>
<td>UT vs. MT = .03</td>
</tr>
<tr>
<td>Cheerfulness</td>
<td>10.86</td>
<td>9.00</td>
<td>9.67</td>
<td>16.50</td>
<td>4.45</td>
<td>5.51</td>
<td>5.51</td>
<td>2.12</td>
<td>AT vs. MT = .03</td>
</tr>
<tr>
<td>Independence</td>
<td>11.86</td>
<td>5.57</td>
<td>5.67</td>
<td>8.00</td>
<td>3.13</td>
<td>4.39</td>
<td>2.08</td>
<td>4.24</td>
<td>FT vs. AT = .01</td>
</tr>
</tbody>
</table>

**Table 2. Variance analysis of the relationship between psychological gender and specific instrumental values**

FT: feminine sex-type; AT: androgynic sex-type; UT: undifferentiated sex-type; MT: masculine sex-type 

PP: planned comparisons
low. When including only two dominant types (feminine and androgynic sex-types) in the analyzes, it was observed that subjects of disparate psychological genders possess different hierarchies of terminal values ($F_{17,204} = 1.95; p = .02; \eta^2 = .14$).

Planned comparisons demonstrated that androgynic subjects placed Equality ($p = .02$) and National Security ($p = .01$) at lower positions in the hierarchy than feminine subjects, while the Inner Harmony value was placed higher ($p = .01$). Masculine subjects placed Freedom at lower positions than feminine ($p = .047$) and androgynic subjects ($p = .03$). Analyzes also showed that subjects with undifferentiated sex-type placed National Security ($p = .03$) and World of Peace ($p = .01$) at higher positions in the hierarchy than androgynic subjects, while the Inner Harmony value was placed lower ($p = .01$). Independently of the type of psychological gender, A World of Beauty was the least important in the hierarchy of terminal values.

Statistically significant differences between the general hierarchy of instrumental values and psychological gender of the subjects was not observed ($F_{17,204} = 1.12; p = .28; \eta^2 = .18$), even after including only dominant types of gender ($F_{17,204} = 1.12; p = .33; \eta^2 = .08$) in the analyzes. Details of the results are presented in Table 2. The higher the numerical value, the lower place in the system of values.

Additional planned comparisons demonstrated that feminine subjects valued Independence less than androgynic and undifferentiated ones. Undifferentiated subjects valued Honesty higher than androgynic ones, Courage and Independence higher than feminine subjects, and Intellect lower than masculine ones. Androgynic subjects placed Cheerfulness at higher positions in the hierarchy than masculine subjects. The least important value in the group was Obedience.

Subsequent analyses examined the relationship between particular personality traits and types of psychological gender (Table 3). As a standard, ten data were used, which allowed to relate the results to a general population.

In the case of the relationship between particular personality dimensions and psychological gender, a statistically significant difference was observed only in relation to extraversion ($F_{3,15} = 7.26; p = .003$). The Hochberg GT2 post-hoc test with bootstrap was conducted (Table 4). The differences in other personality dimensions did not reach the level of significance and it can be stated that the intensity of the majority of traits was average, irrespectively of the type of psychological gender, except conscientiousness, the level of which was raised.

The subjects of androgynic psychological gender were characterized by higher levels of extraversion than feminine subjects ($p = .003$). The average level of this trait exceeded the point of high intensity in their case, while in the case of feminine subjects, the level of extraversion was average. The results of bootstrap confidence intervals also demonstrated higher levels of extraversion in undifferentiated subjects than feminine ones.

### Table 3. Analysis of the relationship between types of psychological gender and personality traits

<table>
<thead>
<tr>
<th>Sex-type</th>
<th>Mean</th>
<th>SD</th>
<th>$F(3,15)$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extraversion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FT</td>
<td>6</td>
<td>1.27</td>
<td></td>
<td>7.26</td>
</tr>
<tr>
<td>AT</td>
<td>8</td>
<td>1.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UT</td>
<td>8</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MT</td>
<td>7</td>
<td>0.71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FT: feminine sex-type; AT: androgynic sex-type; UT: undifferentiated sex-type; MT: masculine sex-type

### Table 4. Hochberg GT2 test – analysis of the relationship between different types of psychological gender and extraversion

<table>
<thead>
<tr>
<th>Dependent var.</th>
<th>Sex-type: level 1</th>
<th>Sex-type: level 2</th>
<th>$p$</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Extraversion</td>
<td>AT</td>
<td>.003</td>
<td>-4.16</td>
<td>-1.65</td>
</tr>
<tr>
<td></td>
<td>UT</td>
<td>.06</td>
<td>-3.85</td>
<td>-1.21</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>.91</td>
<td>-2.25</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>UT</td>
<td>.99</td>
<td>-0.94</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>MT</td>
<td>.31</td>
<td>0.83</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>UT</td>
<td>.69</td>
<td>0.33</td>
<td>2.67</td>
</tr>
</tbody>
</table>

FT: feminine sex-type; AT: androgynic sex-type; UT: undifferentiated sex-type; MT: masculine sex-type

CI: bootstrap confidence intervals
Analyses examining whether the relationship between personality and the hierarchy of values is moderated by psychological gender were also conducted. They were carried out for terminal and instrumental values separately. Due to the abundance of comparisons, only significant results are presented in Tables 5 and 6.

Only one statistically significant result of moderation concerning the relationship between personality traits and the hierarchy of terminal values was obtained. The results demonstrate that in the case of androgynic subjects, when the openness level increases, the importance of True Friendship decreases. These relationships in the feminine, undifferentiated and masculine subjects did not reach the level of statistical relevance.

In the case of instrumental values, also only one statistically significant moderation was observed. The obtained results demonstrate that relationships between personality traits and the hierarchy of values were observed only in the case of androgynic types. It was observed that in the case of androgynic subjects, the increase of agreeableness level is accompanied by an increase in the significance of the Forgiveness value.

**Discussion**

The obtained results did not confirm the domination of androgynic or masculine types of psychological gender in the case of female subjects doing a masculine team sport. Relatively small as the sample might have been, what needs to be stressed is that all subjects were characterized by a very high level of sports abilities, which was supported by the results obtained during international events (e.g. silver medal at the World Championship). In turn, this, suggests that the traits associated with competition, or even aggressiveness, should be noticeable. The obtained result can be interpreted in categories of culture specificity, in which stereotypical feminine traits are still promoted both in the media and education, which strengthens them [34, 35, 36, 37].

Comparative studies on the preferred hierarchies of values point to the observation that androgynic sportswomen were more oriented towards personal terminal values than social ones, when compared to feminine and undifferentiated sportswomen. These results demonstrate that for female athletes of androgynic personality type, individual goals play a more important role, which in turn, may support their sustainability in a sports career and them obtaining higher levels of sports development when compared to feminine subjects. Females of greater intensity feminine traits are less engaged in sports activity and participate in it for a shorter period of time [38]. They are biased towards social goals, which to a greater extent, may force them to resign from their careers under e.g. family pressure. The above is confirmed by Roper’s study [39], in which the subjects claimed the choice of a sports career equals the sacrifice of family life.

As far as instrumental values are concerned, the preferences of androgynic subjects support the above described pattern. Despite the lack of relevant differences in a general system of instrumental values, planned comparisons demonstrated that feminine subjects do not value independence much, i.e. one of the traits necessary to continue undertaken challenges and fulfill given goals.

Interesting results concerning the relationship between personality traits and the hierarchy of values were also obtained. A greater level of openness was correlated with a decrease in the importance of the love and affection value (True Friendship) in the case of androgynic subjects. As far as instrumental values are concerned, for androgynic subjects, the increase in Agreeableness level was accompanied with an increase in the Forgiveness value, which suggests that when the level of this stereotypical feminine trait is lower, compassion for others, which also can be stated as feminine, is lower and athletes are more egocentric.

The results related to extraversion are even more interesting, since for the group under study it was noticed that androgynic subjects are characterized by the high

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**Table 5. Moderation analysis of the relationship between psychological gender, personality and terminal values**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Moderator</th>
<th>Dep. var.</th>
<th>Beta</th>
<th>SE</th>
<th>$F(3.11)$</th>
<th>$p$</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Openness</td>
<td>Sex-type</td>
<td>True Friendship</td>
<td>3.72</td>
<td>.046</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$r_{p} = .90; p_{p} = .006$

FT/UT/MT: $p > .05$

**Table 6. Moderation analysis of the relationship between psychological gender, personality and instrumental values**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Moderator</th>
<th>Dep. var.</th>
<th>Beta</th>
<th>SE</th>
<th>$F(3.11)$</th>
<th>$p$</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agreeableness</td>
<td>Sex-type</td>
<td>Forgiveness</td>
<td>.68</td>
<td>.29</td>
<td>4.49</td>
<td>.03</td>
<td></td>
</tr>
</tbody>
</table>

$r_{p} = -.78; p = .04$

FT/UT/MT: $p > .05$
intensity of this very value. A higher level of extraversion is also correlated with a better mental state, self-belief, and as supported by the study of Baudin et al. [40], greater satisfaction derived from life and doing sports. Extroverts are characterized by greater go-getting energy, they make decisions more quickly, and have a more positive attitude towards the future. Extraversion is connected with better communicativeness, ease of functioning in a group, which seems to be very useful in team sports like field hockey. This confirms previous conclusions that androgynic people are more likely to continue sports careers at a high level, if compared to those who are typically feminine. Feminine types are characterized by the tendency to perceive themselves as not very effective, possessing weaker abilities, yet – as suggested by the Guillet et al. study [38] – they have better relationships with others, especially with their parents.

Conclusions

The present research did not confirm the dominance of masculine or androgynic types among the female field hockey players under study. Therefore, this debunks the stereotype that in the so-called male sports, of which field hockey is a representative, there is no place for women. It is thus possible to reach a master level being a strictly feminine type in a sport typically associated with masculinity. There are no disciplines “closed-off” for feminine women. However, thoroughly analysing the system of values and personality variables it seems that the extravert androgynic type would be a better predictor of sports effectiveness or it could constitute a factor facilitating functioning at the highest sports level. It can therefore be assumed that androgynic extroverts function in professional sports more easily, longer and more effectively.

References


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THE EFFECTS OF A 12-WEEK FITNESS TRAINING PROGRAMME ON CHANGES IN BODY COMPOSITION AND LEVEL OF CARBOHYDRATE METABOLISM IN MIDDLE-AGED WOMEN

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Keywords: Prediabetes, IGT, IFG, diabetes prevention, impaired glucose tolerance, training, body composition

Abstract

Introduction. For metabolic syndrome and type 2 diabetes, prophylaxis is the primary factor modulating the manifestation time of a full-blown disease. Regular physical activity has positive effects on physical fitness, it maintains or increases lean body mass, reduces body fat, and is extremely important: it regulates metabolic processes.

Aim. The aim of the study was to analyze changes in somatic and glycemic indices of middle-aged women with subclinical glycemia after 12 weeks of health training in the form of aerobic exercises.

Material and methods. 15 women (42.7±4.2 years) with documented fasting-state episodes of hyperglycemia and low physical activity were included in the study. The health training programme (aerobics Hi/Low) lasted 12 weeks, and the classes took place three times a week for 45 minutes. Participants were equipped with cardiac monitors and maintained an individually determined heart rate range (±4 BPM). During the first 6 weeks, they exercised at the level of 70.0±1.8%, for the next 6 weeks, 80±2.9% HRmax. The day before and the day after the end of the training programme, body composition was measured and blood was collected for biochemical analysis. The results of glucose and insulin level tests were used to calculate HOMA%B (beta cell activity), HOMA%S (insulin sensitivity) and HOMA-IR (insulin resistance).

Results and conclusion. Post-exercise changes included improvement in somatic indices: body mass decreased significantly from 65.0±3.7 kg to 62.6±3.9 kg, and lean body mass increased from 45.0±1.1 kg to 46.7±1.9 kg. There was a significant decrease in fat mass: from 20.0±2.7 kg to 15.9±3.3 kg. Each subject improved her BMI on average by one unit. In the area of changes in indicators of glycemic control, there was significant improvement in the level of fasting glucose and the HOMA-IR indicator (by an average of 0.41±0.10) and insulin level. HOMA%B and HOMA%S levels showed no significant improvement. In terms of structure, duration and intensity, the proposed training programme can be an effective form of prevention of glycemic disorders for women in their fifties.
Introduction

Criteria allowing for the diagnosis of diabetes include: the occurrence of diabetic symptoms and casual glucose ≥11.1 mmol/l (200 mg/dl), a fasting glycaemia level of ≥7.0 mmol/l (126 mg/dl), or glycaemia 2 hours after the tolerance test during OGTT (oral glucose tolerance test) ≥11.1 mmol/l (200 mg/dl). However, the research by the UKPDS (United Kingdom Prospective Diabetes Study) shows that 50% of patients with newly diagnosed diabetes already have vascular complications, and despite intensive treatment within 10-15 years, the risk of myocardial infarction has not been reduced [1].

The authors suggest that diabetes is diagnosed too late, since making the diagnosis must have been preceded by a long period of impaired glucose metabolism, hence, the observed micro- and macroangiopathies.

Impaired glucose metabolism (prediabetes) includes impaired fasting glucose (IFG) and impaired glucose tolerance (IGT). This condition has a damaging effect on blood vessels (the risk of developing cardiovascular disease increases by 20% in IFG, and by 70% in individuals with IGT), and also increases the risk of developing type 2 diabetes [2]. The risk in IFG patients is 5 times higher in the course of a year, 6 times higher in patients with IGT, and in those with concomitant IFG and IGT, it is 12 times higher. In order to delay the onset of diabetes by several years or to prevent its development, active forms of pre-diabetes treatment with non-pharmacological and/or pharmacological methods should be implemented [3-5]. Among the risk factors for pre-diabetes and diabetes are: family history of the disease, metabolic syndrome, dyslipidemia, hypertension, and additionally in women: polycystic ovary syndrome (PCOS), gestational diabetes and birth of a baby weighing more than 4 kg.

Glycemia disorders may also be generated due to pharmacological treatment. Drugs that can generate disorders in carbohydrate economy are primarily glicocorticosteroids, but such an effect can also be caused by antihypertensives (thiazide diuretics, furosemide, clonidine, prazosin, diazoxide, nonselective β-blockers), drugs acting on the central nervous system (phenytoin, benzodiazepines, opioids), but also thyroid hormones, nicotinic acid, immunosuppressant and anticancer drugs. The use of polypragmasia, that is several drugs at the same time, can especially generate carbohydrate metabolism disorders. This makes non-pharmacological strategies to improve carbohydrate metabolism extremely desirable and necessary nowadays. In Poland, the percentage of people with IFG is 16.5%, ranking first place among European countries, and fourth in the world [6]. Early diagnosis of prediabetes, the elimination of risk factors and effective treatment of all disorders affecting their development is the basis in diabetes prevention. It is prophylaxis that is the primary factor modulating the manifestation time of full-blown disease.

Regular physical activity has positive effects on physical fitness, it maintains or increases lean body mass, reduces body fat and regulates metabolic processes [7,8]. Even though much is already known about its positive health effects, for years, research has been conducted on what type of activity is most beneficial. It is generally accepted that moderate intensity exercise promotes health and prevents risk factors for civilization diseases. It is also important to choose a kind of activity that will be well tolerated. As indicated by studies, adult women have higher rates of kinesiophobia, and therefore, this group requires special attention, and the forms of activity proposed in health training must take the specific needs of this group into account [9,10]. Alejziak [11] pointed out that one of the most popular activities performed by women is aerobic classes, which led us to choose this form of training.

The aim of this study was to analyze changes in the level of somatic and glycemic indicators in middle-aged women with subclinical glycemia, after 12 weeks of aerobic exercise.

Material and methods

Description of the study group

Among the volunteers who reported for participation in this study, fifteen non-smoking females (42.7±4.2 years) with low levels of physical activity and similar body composition were selected. The inclusion criteria also included submitting a statement regarding contingent fasting glucose levels above 5.5 mmol/l within a 12-month period preceding the study and no usage of drugs sensitizing insulin-sensitive cells to insulin or other antidiabetic and dietary supplements acting similarly. The criteria of exclusion from the study are presented in Table 1. The Participants of the study group women were asked to maintain their previous eating habits, which were earlier verified for quantitative and qualitative deficiencies. Physical activity level (PAL) was determined using the shortened version of the International Physical Activity Questionnaire (IPAQ) [12], which concerned previous and current physical activity. The study included women who reported previous physical activity below 600 METs (minutes/week), which according to IPAQ, indicates low physical activity [12].

According to the ethical principles of the Declaration of Helsinki, the study participants were informed about the purpose and methodology of the research and were able to withdraw from the study at any stage. In addition, the participants expressed their written consent to participate in the study. The research project was approved by the local Bioethics Committee (No. 137/KBL/01L/2013).
The effects of a 12-week fitness training programme on...

The aerobics (Hi/Low) health training programme lasted 12 weeks. Workouts took place at the gym, from March to May, three times a week for 45 minutes, always in the afternoon under the supervision of an instructor. All of the women included in the study programme took part in 36 classes. All participants were equipped with heart rate monitors (Polar RS400) and maintained their individually determined heart rate (±4 BPM) during each session. Each training session consisted of three parts: a warm-up (5.0 minutes), the main part (35 minutes) and the final stage (5.0 minutes). The warm-up included a set of stretching exercises to prepare the body for the main exercise part. The aerobic and strength efforts dominated the main part, during which choreographic combinations were performed at varying intensities (Hi/Low). During the first 6 weeks, women exercised at 70.0±1.8% HRmax to rhythmic music at a pace of 128-135 BPM, and then, throughout the following 6 weeks, the intensity was increased to 80.0±2.9% HRmax and the music pace to 135-145 BPM. In this part of the workout, the participants performed a set of strengthening exercises with the load being their own weight. In the first 6 weeks, three different exercises involving the muscles of the arms, legs, abdomen and back were used. Each exercise was repeated 8 times in three series. A total of 72 repetitions for the shoulder, leg and abdominal muscles were performed. In the following 6 weeks, the number of series was gradually increased to reach the final 120 reps of the series. At the end of the session, relaxation exercises were performed. Maximum heart rate (HRmax) was estimated according to the formula HRmax = 208 - 0.7 x age [13]. During the whole duration of the sessions, the women monitored their heart rate using Polar RS400 watches. The participants attempted to maintain their assigned heart rate range, with individually determined intensity ranges. When the intensity of the exercise started to reach the upper limit of the range, the women were expected to decrease the intensity of the exercise by skipping a few sequences of steps.

Analysis of selected somatic parameters

Measurements were taken in the morning in a fasting state, before and after the completion of the training programme. Body mass (BM), fat mass (FM), fat percentage (F%) and lean body mass (LBM) were determined using the bioelectric impedance method with the Jawon Medical IOI-353 (Korea) body composition analyzer. In order to ensure measurement reliability, they were conducted in the same room at a controlled temperature and humidity each time, the participants were in a fasting state and were asked to avoid physical activity (moderate to severe) 2-3 hours before the measurements. They were also asked not to use any foot or hand cosmetics [14]. Body height was measured using the Martin anthropometer (USA) with a measurement accuracy of 1 mm.

Biochemical analyses

Blood samples for biochemical analysis were collected in a fasting state in the morning, before and after 12 weeks of training. Insulin was determined using the electrochemiluminescence method (ECLISA), apparatus: Cobas E 411 (Roche), glucose level: using the hexokinase method, apparatus: Cobas E 411 (Roche). The obtained results were used to calculate the following indicators: HOMA% B (beta cell activity), HOMA% S (insulin sensitivity) and HOMA-IR (insulin resistance) [15].

Statistical analysis

Statistical calculations were performed using Statistica PL v 10.0 (StatSoft, Inc, 2011). The results are presented as mean±standard deviation (SD). Using the Shapiro-Wilk test, the compatibility of variables with normal distribution was checked. Normal distribution variables were compared using analysis of variance (ANOVA). The Kruskal-Wallis test was used to compare the variables significantly deviating from the normal distribution. Pearson’s linear correlation coefficient test was used for variables with normal distribution. Spearman’s rank correlation test was used for variables that did not comply with normal distribution. All demonstrated differences were statistically significant at the level of p < 0.05.

Results

Post-exercise changes included improvement in somatic indicators: body mass decreased significantly from 65.0±3.7 kg to 62.6±3.9 kg, and lean body mass in-
creased from 45.0±1.1 kg to 46.5±1.9 kg. There was a significant decrease in fat mass: from 20.0±2.7 kg to 15.9±3.3 kg. Regarding BMI, an average improvement of a unit was noted for each. The somatic characteristics of the studied women during the pre- and post-exercise states are presented in Table 2. In the area of glycemic changes, significant improvements in fasting glucose, insulin levels as well as HOMA%B and HOMA%S were also noted, but these changes were not statistically significant. The HOMA-IR index decreased on average by 0.41±0.10 (p = 0.0183). The biochemical characteristics of the examined women are shown in Table 3. Correlation analysis indicated the presence of moderate positive correlations between baseline body mass and fasting insulin changes after 12 weeks of training (Pearson r = 0.5573, p = 0.0390, n = 15) and between baseline and HOMA-IR improvement (Pearson r = 0.5644, p = 0.0284, n = 15) after 12 weeks of training.

Discussion

Physical activity has a positive effect on various aspects of human life, from body composition to psychological and sociological changes. The first large study analyzing the effects of physical activity on carbohydrate metabolism was a 5-6 year observation of 200 subjects with reduced glucose tolerance (IGT) or type 2 diabetes [16]. And these studies have found numerous followers (trials were conducted in groups ranging from several hundreds to several thousands of overweight individuals and those with glucose intolerance) [17,18]. The authors pointed out that the improvement in VO2max and body mass correlated with the increase in glucose tolerance, which is also confirmed by this study with regard to body mass.

The results of many studies seeking protective mechanisms for the effects of regular physical activity on carbohydrate metabolism indicate the activation of kinase protein activated by AMP (AMK) [8]. Improved insulin sensitivity of hepatocytes and muscle cells, increased glucose uptake by skeletal muscles, and general management of glucose in the body, inter alia resulting from the inhibition of gluconeogenesis, can be combined with this mechanism. The mechanism involving AMPK is common for physical activity and metformin action, which lowers blood glucose levels due to LKB1/AMPK activation [19].

The skeletal muscles are the primary location of glucose uptake. Insulin enhances the intensity of this process by stimulating the movement of the glucose transporter (GLUT4) into the muscle cell membrane. It has been shown that AMPK activation in the muscles improves sugar uptake performance but by launching a separate, insulin-independent mechanism, which was demonstrated by an AMPK-stimulated increase in glucose transport intensity in the skeletal muscles of patients with insulin resistance [8].

Regular physical activity also has a documented effect on body fat content; regardless of age, people less physical active have more adipose tissue, which may also be linked to the activation of the AMPK axis [8]. The regular aerobic exercise (Hi/Low) in our study, performed three times a week for 12 weeks, resulted in weight loss,
The effects of a 12-week fitness training programme on fat mass reduction (FM) and a significant increase in lean body mass (LBM). Furthermore, the results of our research are consistent with the results of other authors regarding the positive impact of health training on somatic body components [20-22].

A very important result observed in our study is the increase in LBM. The decrease in muscle mass of the lower limbs can be associated with decreased muscle strength and lead to weakness, poor condition of the lower limbs and gradual loss of motor skills that are common in people with diabetes [23-25]. Body mass reduction in older adults has wide clinical implications. It has been shown, inter alia, that small changes in skeletal muscle mass are associated with poorer strength of the lower limb in the elderly [24], with an increased risk of mortality [26,27].

Among the subjects without diabetes, hyperglycaemia was an independent risk factor of lean body mass reduction. Interesting observations can be found in the works by Kalyani et al. They indicated that patients with undiagnosed diabetes had lower LBM levels by 3-4% than patients with pharmacologically maintained normoglycemia [28,29]. The relationship between insulin resistance and LBM loss in non-diabetic men was assessed using the HOMA-IR indicator [30] or the HbA1c glycated hemoglobin level [29]. Therefore, it is difficult to determine whether the increase in LBM observed during our study is the cause or effect of improved carbohydrate metabolism.

Insulin resistance is associated with decreased synthesis of muscle protein and altered kinetics of amino acids necessary for this synthesis [31]. People with hyperglycaemia often have higher FM values, which is also associated with skeletal muscle mass loss, but due to different molecular mechanism, these phenomena are not always directly dependent [30].

Many studies [32,33] indicate that aerobic training causes fat reduction in the body, which is mainly related to fatty acid oxidation during the β-oxidation process in the mitochondria of muscle tissues. In obese women, Despres et al. [34] have shown that aerobic training leads to a relatively rapid decrease in abdominal fat mass. In obesity, it is important to take into account the two components of the body: systemic body fat and muscle mass. The results of our study have shown a reduction in fat percentage and lean body mass (LBM) in the female body. This fact influenced the improvement in body composition among the study group, as confirmed by the opinions quoted by the authors cited in this publication, and the results of studies by researchers in this field [35].

The proposed training programme resulted in significant improvement of HOMA-IR (p = 0.0183). Zehszaz [36] showed the positive effect of 12 weeks of aerobic training on the insulin resistance index of women leading a sedentary lifestyle. In that study group, the BMI of the subjects was about 30. Our results show a similar positive effect of exercise interventions in a group with normal BMI values (baseline: 23.8±2.0). However, there was a correlation between baseline body mass and the degree of HOMA-IR improvement, indicating that at baseline, greater body mass facilitates post-exercise improvement in insulin resistance.

Our proposed training programme has brought forward both somatic and metabolic positive changes, thus contributing to reducing the risk factors of many civilization diseases.

The Polish, female population in their 50s is a relatively difficult recipient of health programmes based on different forms of physical activity [9,10]. However, our proposed training programme was well received by the volunteers who entered the project, and all the women completed the 12-week programme with perfect, 100% records of attendance.

**Summary**

The changes observed after the 12-week health training programme in our study included improvements in somatic indicators and fasting plasma glucose levels. The proposed exercises in terms of structure, duration and intensity can be an effective form of preventing glycemic disorders in women in their 50s. Such a programme of health activity can affect the modifiable risk factors of many civilization diseases.

**Acknowledgements**

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References


The effects of a 12-week fitness training programme on...
In the context of human posture, stability can be referred to as the ability to restore a typical position of the body lost in space due to the action of destabilizing factors, such as the activity itself or some external forces [1]. In turn, balance is the desirable state achieved thanks to this capacity, characterized by the self-sustained vertical position of the body with the head as the highest point and the projection of the overall center of mass within the boundaries of the support field [1, 2].

Postural stability is conditioned by proper functioning of the sensory organs: vision, vestibular as well as proprioceptors, and by the ability to continually respond...
to the varying internal and external forces with the use of muscles under the control of the nervous system [1, 3-5]. This is largely done through reflexes [3] initiated by continuous transmission and analysis of information in the nervous system about the current postural state of the organism [1, 3]. Correction of the body’s position in space is based on the mechanism of neurophysiological feedback. Studies report that people are primarily focused on visual and somatosensory information during standard daily activities and that, with sudden changes in direction of movement or changes in head position, the use of vestibular information for balance control increases. The specificity of team sports played with a ball and with the participation of two teams shows a strong correlation with visual information [7]. Therefore, it is reasonable to test players under conditions of activation of this sensory organ. According to the research conducted by Paillard et al., it is shown that the share of visual information in soccer players is lower at higher levels of the game [7]. This is probably due to the transfer of the athlete’s attention from the ball to the current situation on the field, which may cause a preference for proprioceptive information in balance-maintaining mechanisms. It is worth pointing out that the stability of soccer players is greater than that of individuals not performing any sports, regardless of the test selection and its connection with soccer [8].

The efficiency of these mechanisms allows for effective movement and reduces the risk of injuries in sports [4, 9, 10]. Postural stability seems to be of particular importance to those playing team players such as soccer [4]. Direct physical contact with opponents and the external forces generated by them require increased activity of the body to maintain the overall center of mass in the support field. Greater stability requirements from the body during training and competitions have a positive effect on the players’ performance. For example, as demonstrated Sunsdstrup et al., older people training soccer throughout their life show significantly better postural stability compared to their non-training peers [11].

In soccer, one of the factors potentially influencing the uneven distribution of forces on an athlete’s lower limbs is natural lateralization [12]. While the importance of this phenomenon for the actions of the upper limbs is more deeply understood, in the case of the lower limbs, it is still unknown how it can affect various aspects of motor function, including postural stability. In normal daily activities such as sitting up, locomotion, etc., the lower limbs are loaded symmetrically [5, 13]. Long-term sports training, especially in which the lateralization of the lower limbs is naturally exposed, may lead to disturbances in postural stability, and consequently, to overload and injury [14, 15]. Such a sport is certainly soccer, in which the dominant limb is often used to perform a variety of kicks during the game, while the role of the non-dominant limb is reduced to support and amortization. Many authors have suggested the formation of asymmetric neuromuscular adaptations in the lower extremities if athletes performing sports which are explosive in nature, with varying direction of movement and complex coordination [15-17].

Analyzing different sources in literature, it can be stated that the nature of the work of the individual lower limbs of a person playing soccer differs from each other. It would be expected that factors such as game level, training period or specificity of the discipline as well as morphological changes resulting from regular participation in training units be strongly correlated with postural stability [18]. Such a conclusion can be reached, for example, by pointing out that ND (ND, the non-dominant limb, usually the supporting leg) mainly functions within the closed kinematic chain, whereas D (the dominant lower limb, which more often performs the kick) – in the open one [19]. According to Blaszczyk [1], in the closed chain, the movement of one of its segments requires movement of the remaining segments, and in the open chain, individual segments can move independently of each other and some of them may even be at rest. Consequently, there is different activation of the muscles supporting these two different kinematics. In the closed chain, mainly antigravity, usually one-jointed, muscles are stimulated, which are responsible for static load transfer by slow contraction [20]. This action is based on the mechanism of sensory feedback and gravitational stimulation. In the kinematic open chain, however, more frequent ballistic movements are performed, where recurrent muscle spasms are mainly recruited based on phase contractions, often with the elimination of gravitational influence, which minimizes sensory stimulation and reduces the efficiency of the feedback mechanism [20].

It has already been proven that such forms of activity result in deepening the structural asymmetry of the lower limbs [5, 21]. So far, it has not been found that structural changes affect the development of functional differences in the sphere of human postural stability.

The aim of the study was to evaluate differences in postural stability in standing on one leg - the dominant and non-dominant lower limb - in professional soccer players. The authors hypothesized that the ability to maintain postural stability should be different when standing on the D leg and different when standing on the ND one, with the proviso that the ND limb is better predisposed to this role in professional players. The additional objective was to analyze the differences between limbs, including additional grouping variables: age, body mass and height, the volume of training per month aimed at improving stability, the number of training units per week and overall competitive experience.
Material and methods

Participants

In order to compile the research material, a study notice was issued among local clubs. 50 soccer players from the I-V leagues reported for the study. During the interview, selective targeting was used to verify the selection criteria. Inclusion criteria were as follows: regular training (three times or more per week) and absence of past joint injuries such as ankle sprains, knee or hip anomalies (similar injuries could negatively affect proprioceptions). Additionally, the participants declared that they had completed a full training process and have been taking part in professional league games for more than three years (the level was not specified as there has been no high level correlation with the level of competition so far). Such an intervention was intended to ensure that only those with progressive, adaptive morphological changes were directly involved in the study, which are directly related to the duration of the traineeship and could be predisposed to increased functional differences between the lower limbs [23]. At this stage, 27 of the 50 competitors were selected. The characteristics of their somatic structure and basic information on the study group is given in Table 1.

Tools

The study was conducted on the SD Balance System (Biodex®, Inc., Shirley, NY, USA) stability platform. The machine is designed to induce instability of the surface in all directions (360°) with a maximum tilt value equaling 20°. The sampling frequency is 50 Hz. The system orders the levels from the hardest/least stable (level 1) to the easiest/most stable (level 12) [24]. All attempts were conducted at the level 5 difficulty. This is an average value and is reported in literature as one of the preferred test stabilities [25]. Lack of ability to maintain balance on the platform set at the 5th difficulty level resulted in exclusion from further participation in the experiment.

Procedure

The individuals who met the selection criteria made an appointment for the measurements to be taken by the examiners. In order to obtain a high degree of measurement reliability, the test was conducted at a similar time, in a quiet room, and at a constant temperature to create the necessary conditions for reproducibility and maximum concentration needed to test postural stability. In addition, the study was always conducted before training and never on the day following exhaustive exercise or a game. The above mentioned test criteria were adopted

Table 1. The mean (\(X\)), standard deviation (SD), minimum values (min.) and maximum values (max.) of body height, body mass and body mass index (BMI) in the group of participants, including preferred dominant right (R) or left (L) lower limb

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Dominant limb</th>
<th>(X)</th>
<th>SD</th>
<th>min.</th>
<th>max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height [cm]</td>
<td>L (n=3)</td>
<td>179</td>
<td>4.6</td>
<td>174</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td>P (n=24)</td>
<td>183</td>
<td>5.7</td>
<td>169</td>
<td>193</td>
</tr>
<tr>
<td></td>
<td>Overall (n=27)</td>
<td>182.5</td>
<td>5.6</td>
<td>169</td>
<td>193</td>
</tr>
<tr>
<td>Age [y]</td>
<td>L</td>
<td>21</td>
<td>1</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>21.3</td>
<td>1.5</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>21.3</td>
<td>1.4</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Body mass [kg]</td>
<td>L</td>
<td>73.7</td>
<td>4</td>
<td>70</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>77.7</td>
<td>6.4</td>
<td>65</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>77.2</td>
<td>6.3</td>
<td>65</td>
<td>95</td>
</tr>
<tr>
<td>BMI [kg/m²]</td>
<td>L</td>
<td>23</td>
<td>0.7</td>
<td>23.3</td>
<td>24.6</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>23.2</td>
<td>1.6</td>
<td>22.4</td>
<td>25.7</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>23.2</td>
<td>1.5</td>
<td>22.4</td>
<td>25.7</td>
</tr>
<tr>
<td>Amount of training per week [h]</td>
<td>L</td>
<td>10</td>
<td>2</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>8.6</td>
<td>2.5</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>8.7</td>
<td>2.5</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Amount of stability training per month [h]</td>
<td>L</td>
<td>3.3</td>
<td>2.3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>1.8</td>
<td>1.9</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>2</td>
<td>1.9</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Training experience [y]</td>
<td>L</td>
<td>11.3</td>
<td>2.1</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>10.6</td>
<td>3.6</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>10.8</td>
<td>3.5</td>
<td>5</td>
<td>17</td>
</tr>
</tbody>
</table>
to prevent distortion due to reduced functional status of the body during the regeneration phase. After the warm-up on a stationary bike (5 min, 100 w), the subject performed the trial test on a Biodex device connected with a debriefing in order to acquaint himself with the sensitivity and mechanism of the machine. During this time, he could ask questions and explain the problems. Subsequently, the proper measurements were conducted.

During the measurement, the subject was asked to assume a standing position with a slight flexion of the supporting limb in the knee joint (15°) on the unstable platform. After placing the foot of the supporting leg on the platform, the subject was not allowed to change its position. To facilitate this task, an aluminum frame was mounted on the platform (Fig. 3), close to which the participant placed the lateral edge of his foot and heel. The other lower limb was bent at a 90° angle in the knee joint. The subject was instructed to not let his lower limbs touch. The upper limbs were in a relaxed position, crossed on the chest in such a way that each hand rested on the opposite shoulder (Fig. 1). This setting of the upper limbs was adapted to minimize their contribution to restoring balance. Prior to the beginning of the measurement, the participant was asked about his readiness to begin the study. The standard Biodex postural stability test was based on mean values and standard deviations of three parameters: anterior-posterior stability index (APIS), lateral-medial stability index (MLIS) and overall stability index (OIS), which were the result of two previous ones [4]. Measurements of APIS and MLIS indexes show the average deviation of the moving platform from the level (in degrees) of a given reference plane during each 20-second tests. This measurement is characterized by a high level of reliability. In the pilot studies, the following interclass correlation coefficients (ICC) were calculated for the individual parameters: for OIS - ICC = 0.90; for APIS - ICC = 0.86; For MLIS - ICC = 0.76 [20].

The entire procedure lasted approximately 9 minutes. The subject was obliged to report any inconveniences and could stop the test on request. Despite this fact, all those qualified for the tests, completed the full measurement cycle.

Statistical analysis

Statistica 10 (Stat Soft, USA) was used for statistical analysis of the obtained results. The differences between the groups were analyzed using the Mann-Whitney U test. The critical level of statistical significance was determined at $p < 0.05$. Comparison of the dominant limb with the non-dominant one was carried out for the whole group, and taking the following grouping variables into account: age, body height and mass, overall training experience, number of workouts per week and the number of training sessions per month aimed at improving stability were determined. The authors decided upon the mentioned grouping variables due to the numerous sources in literature indicating that somatic build [26], age [27] and level of sports advancement [28,26] are key factors, and in addition to existing injuries [29], the ability to concentrate [30] or the difficulty level of the performed motor behaviors [30] can significantly differentiate the

### Table 2. The Mann-Whitney U nonparametric test for independent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mann-Whitney U test (with correction for continuity) (Analysis of soccer players)</th>
<th>Relative to variable: kod</th>
<th>Marked results are significant at $p&lt;.05000$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rank Sum</td>
<td>Rank Sum</td>
<td>Z</td>
<td>p-value</td>
</tr>
<tr>
<td>OIS</td>
<td>687.5000</td>
<td>797.5000</td>
<td>309.5000</td>
</tr>
<tr>
<td>OISdev</td>
<td>724.5000</td>
<td>760.5000</td>
<td>346.5000</td>
</tr>
<tr>
<td>APIS</td>
<td>704.0000</td>
<td>781.0000</td>
<td>326.0000</td>
</tr>
<tr>
<td>APISdev</td>
<td>696.5000</td>
<td>786.5000</td>
<td>318.5000</td>
</tr>
<tr>
<td>MLIS</td>
<td>677.5000</td>
<td>807.5000</td>
<td>299.5000</td>
</tr>
<tr>
<td>MLISdev</td>
<td>685.0000</td>
<td>800.0000</td>
<td>307.0000</td>
</tr>
</tbody>
</table>
Figure 1. Left: Subject’s posture during the postural stability test. Top right: The screen showing the movement of the subject’s overall center of gravity. Bottom right: Stabilographic platform with aluminum frame allows setting the examined foot in default position.

Figure 2. Mean values (frames represent standard error of mean, whiskers - standard deviation) for the overall stability index (OIS), anterior-posterior stability index (APIS) and the medial-lateral stability index (MLIS) for the dominant (D) and non-dominant (ND) limbs.
The categories for each variable were obtained by dividing the entire group into subgroups of larger and equal values, and smaller than the median of the given grouping variable. The full descriptive characteristics for groups along with their divisions is given in Table 3.

**Results**

The results showed no significant difference between the dominant (D) and non-dominant (ND) limbs within the area of the mean values of all indexes describing postural stability for the general population (for all indexes $p > 0.05$) (Tab. 2). Although the results of most stability indexes were slightly lower for the ND than the D limb, the differences between them were statistically insignificant (Fig. 2). Also, the values of the standard deviations of the assessed stability indexes did not significantly differ between D and ND (for all indexes $p > 0.05$) (Fig. 3). Differences between D and ND did not occur in any of the categories of the included grouping variables (for all $p > 0.05$). Therefore, the authors decided to reject the null hypothesis. The detailed descriptive statistics of all the tested stability indexes for the overall group of participants and divided into categories of all grouping variables are presented in Table 3.

**Discussion**

The existence of differences in the function, morphology or the type of recruited muscle fibers between the lower limbs during soccer has been repeatedly proven by other authors [26,31-36]. The aforementioned knowledge was the basis for initiating research related to postural stability during one-leg standing. However, the results did not show the existence of statistically significant differences between limbs regarding the inclination degree of the platform describing postural stability. Similar results have also been reported by other researchers [4, 25, 37-39], but the variations in research groups and research tools presented in them still leave gaps in the discussed subject matter. Among the authors, there have even been suggestions that D is a more stable support during one-leg standing [40]. However, the obtained results do not allow for confirmation of a similar relationship. Some authors suggest that soccer training does not directly affect the balance of the players in a one-leg
standing position. Minimizing differences in lateralization of the limbs is likely to be influenced by the activity of connections between the cerebral hemispheres [42]. It may be the case that among professional players, similar mechanisms work better, allowing for greater stability without lateralization in function. Still, new attempts to explain the lateralization of the lower limbs with respect to the possibility of postural stability are evidence of the difficulty in resolving this problem. Tracey et al. [43] even presumed the presence of contralateral functional links between the lower limbs. According to those authors, higher acceleration and precision of movement characteristic of the kicking leg is correlated with better stability of the opposite lower limb. This analysis confirmed the existence of such dependence, but only in terms of acceleration and precision, and stability of the ND limb [43]. In the opposite case, this correlation does not occur. The results obtained by Tracey et al. demonstrate an original approach among other publications, as it does not show differences in the same attributes of the lower limbs but rather the link between their different characteristics [43].

It is worth noting that during the test, the players used visual feedback. There is no clear answer in the literature to the question of whether closed-eyed testing is of greater value in balance tests [44], although other mechanisms of body control are undoubtedly subjected to evaluation. Testing with closed eyes, thus limiting the visual sensory information, greatly affects the results [7, 44, 45] and increases the differences between competitors. It is noted that athlete testing should always be carried out while considering the mechanisms occurring in a given sport discipline. In the future, it should be differentiated whether the players should observe the panel with the COM displayed during the test, if should stare at the point in front of them or track an artificially induced sports competition situation. In itself, such categorization differentiates the level of difficulty irrespective of the degree of platform inclination. Screen observation gives direct error-free information and testing under such conditions seems to be the least challenging for the players. Gatchev et al. indicate that COM tracking on the screen reduces swaying of players compared to the group staring at a given point. In addition, swaying decreases as the image on the screen is enlarged [46]. Observation of a specific point on the wall would reduce visual feedback, still being just a static imitation of game events. An interesting proposition seems to be simulation of mechanisms occurring in soccer, for example, by two players passing the ball to each other and the tested subject tracking the event. Perhaps such a test would make it possible to assess differences between the limbs.

Lockie et al. point out that practical exercises of dynamic postural stability are those producing a short-last-

ing stabilization response after performing a jump (i.e. hop and hold) [19]. It is worth noting that when testing stability in laboratory conditions, we only deal with the correction of the motion of the moving platform in a closed kinematic chain and at a fairly uniform rate. Perhaps the differences between the lower limbs would appear in the case of reducing the time of the postural stability test to that closer to the real time of football kicks, and in the case of testing the motion pattern, more similar to the game situation, that is, “hop and hold” type.

In the literature, it is indicated that limited central stability may be a factor significantly impeding the differentiation of postural stability between two limbs [47]. In such a case, it would be worthwhile to carry out pelvic-lower back area stability measurements and to divide the entire group according to the obtained results. The possibility to enrich research and improve the homogeneity of the test group according to motor skills is given by conducting evaluation of the advancement in functional movement patterns with the Functional Movement Screen (FMS), which is used in everyday work with soccer players [48].

As far as the presented results are concerned, the lack of differentiation of stabilization capacity of the D and ND limbs can be attempted to be explained by the long duration of the study, which caught the subjects at different stages of motor preparation during the season, but the group remained fairly homogeneous and did not contain many outlying values which could negatively affect the results. Considering the functional symmetry of the lower limbs in daily motor tasks, it is important to bear in mind the possibility of functional differentiation of the lower extremities for postural stability [8]. It can be presumed that this is partly due to effective, neural, contralateral communication facilitating control of stability and preventing over-functional asymmetry between the lower limbs [8]. The results of this study coincide with the opinion of Grouios et al. that limb preference is primarily determined by behavioral context and intentional adaptation to the type and complexity of motor behavior [49]. Thus, it is not a derivative of anatomical asymmetries or neuronal development factors [49].

The fact that the participants subjectively selected the dominant limb regarding it as the limb more often used to kick the ball is one of the limitations of the presented study. There is no unanimity regarding whether the limb always preferred by the athlete is the dominant one, or if it is also determined by other factors. The authors have chosen the manner often described in literature [15, 50-52] and more credible than the questionnaires or surveys used for this purpose, often not related to the reality of sports [49].

The subjective feelings of the participants may also be an indication that those who represent lower leagues,
Table 3. Descriptive statistics (mean values [standard deviation] minimum-maximum) for the overall stability index (OIS), medial-lateral stability index (MLIS) and anterior-posterior stability index (APIS) for all subjects and divided into categories of grouping variables. These categories were obtained by dividing the total group into people who scored higher (or equal to) and smaller than the middle value - median (Me) of the grouping variable.

<table>
<thead>
<tr>
<th>Grouping variables</th>
<th>Categories of grouping variables</th>
<th>Limb</th>
<th>Average sways of platform (grades)</th>
<th>Standard deviations of average platform sways (grades)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>OIS</td>
<td>MLIS</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>≥ Me (n=14)</td>
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<td></td>
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<tr>
<td></td>
<td>&lt; Me (n=13)</td>
<td></td>
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<td></td>
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<tr>
<td>Body height</td>
<td>≥ Me (n=14)</td>
<td></td>
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<tr>
<td></td>
<td>&lt; Me (n=13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass Me=78</td>
<td>≥ Me (n=14)</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>&lt; Me (n=13)</td>
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</tr>
<tr>
<td>Training experience Me=12</td>
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<tr>
<td></td>
<td>&lt; Me (n=13)</td>
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<tr>
<td>Amount of training per week Me=9</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>&lt; Me (n=13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount of stability training per month Me=2</td>
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<tr>
<td></td>
<td>&lt; Me (n=13)</td>
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</table>

Przemysław Dębski, Jacek Mielończyk, Rafal Gnat

Antropomotoryka
in spite of their starting position, significantly hindering similar behavior; were more likely to use the upper and lower limbs to influence the results. In the future, it is also worth considering breathing of players during the test, which is also indicated as a factor influencing postural stability [53].

The natural path to continue the struggle with this issue seems to be an attempt at conducting more extensive research at the highest levels of competition, but it is difficult to find justification for such behavior in literature. So far, a high correlation between balance level while standing on one leg and the level of competition has not yet been proven [22].

Conducting a similar study among women for whom greater differences in limb strength, coordination and postural control would be worth considering [54]. Perhaps the results obtained among a female research group would provide valuable guidance.

**Conclusions**

The obtained results do not indicate the existence of significant differences between the dominant and non-dominant lower limb in the ability to maintain postural stability among professional soccer players. There are no differences in stability between limbs, including grouping variables: age, body mass and height, volume of training per month aimed at improving stability, number of training units per week and overall competitive experience. Postural stability testing is a complex process that requires uniformity of methodology and consideration of factors rarely taken into account in the literature up to date.

**References**


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The role of systematic physical activity as an important component of a healthy lifestyle has been widely emphasized for many years, especially in recent times [1, 2, 3, 4, 5, 6, 7]. The International Physical Activity Questionnaire [8] is used to assess development trends within countries, occupational groups and current control of a particular occupational or social group.

Undoubtedly, the level of physical activity is very important among uniformed workers, as already pointed out in literature over a decade ago [9], indicating the high risk of cardiovascular diseases and traumatic motor system injuries in a group of police officers and fire-fighters.

Cases of exposure to various diseases also occur among penitentiary employees due to their contact with prisoners [10, 11, 12]. Out of concern for the mental health and physical fitness of this professional group, fitness improvement holidays are commonly recommended [13, 14, 15]. The specificity of working with prisoners, resulting from the deprivation of needs of people denied their freedom, is also emphasized [16, 17, 18]. The role of testing their physical fitness is also stressed. Also out of concern for the health and physical activity level of prison staff, the role of testing their physical activity is also stressed [19]. Therefore, in following the lifestyle of prison employees, it is important to know their state of physical activity [20, 21, 22, 23, 24, 25].

**Study aim.** The proper physical activity of prison staff is an indispensable component of their professional work. The purpose of the study was to: identify the level of physical activity of officers employed in the security department – protective specialization and others – administrative specialization, and demonstrate differences in their: free time, self-evaluation of physical fitness, number of performed sports disciplines and BMI.

**Material and methods.** The study was carried out in 2015 among 100 employees of the Biała Podlaska Penitentiary using the long-standing IPAQ questionnaire supplemented with original questions regarding amount of free time, self-evaluation of physical fitness, number of performed sports as well as height and body mass.

**Results.** In the distinguished groups of prison service officers (protective and administrative specializations), the desired direction of differences in physical activity was demonstrated in the absence of their relevance. Similar relationships were found in other positive health and lifestyle indicators. In this range of differences, attention is given to high body mass index (BMI), especially in the administrative specialization.

**Conclusions.**
1. The officers of both specializations are characterized by high levels of physical activity.
2. The small number of performed sports appears to be a less favourable fact.
3. The occurrence of obesity in administrators should be a signal to implement lifestyle changes, including greater concern for physical activity and nutrition.

**Abstract**

The proper physical activity of prison staff is an indispensable component of their professional work. The purpose of the study was to: identify the level of physical activity of officers employed in the security department – protective specialization and others – administrative specialization, and demonstrate differences in their: free time, self-evaluation of physical fitness, number of performed sports disciplines and BMI.

In the distinguished groups of prison service officers (protective and administrative specializations), the desired direction of differences in physical activity was demonstrated in the absence of their relevance. Similar relationships were found in other positive health and lifestyle indicators. In this range of differences, attention is given to high body mass index (BMI), especially in the administrative specialization.

1. The officers of both specializations are characterized by high levels of physical activity.
2. The small number of performed sports appears to be a less favourable fact.
3. The occurrence of obesity in administrators should be a signal to implement lifestyle changes, including greater concern for physical activity and nutrition.
Research aim, material and method

Research aim

The aim of this research is to study the physical activity of the Biała Podlaska Penitentiary officers and to indicate differences among persons in the security department – protective specialization and others – administrative specialization in the scope of: areas of activity, free time, self-evaluation of physical fitness, the number of performed sports and BMI.

Research material

The study was conducted in April 2015 among 100 out of the 119 officers employed at the Biała Podlaska Penitentiary. The protective specialization included 61 individuals at the average age of 36.7 years, and 39 administrative employees at an average age of 38.2 years. The study group consisted of 93 men at the average age of 37.2 years (23-52 years), and 7 women at the average age of 37.7 years (30-43 years). All the studied women were employed in the administrative specialization.

Research method

Diagnostic survey was the chosen research method, the questionnaire-interview technique using the International Physical Activity Questionnaire (IPAQ) in the Polish long version, available at www.ipaq.ki.se, was supplemented with our own questions regarding height and body mass, free time, self-evaluation of physical fitness and the number of performed sports disciplines. The answers to the questions on the IPAQ sheet helped to calculate the studied officers’ total time devoted to physical activity during the week, expressed in MET – min./week (MET), and in individual areas of their life: at work, during mobility, at home and during sports.

Statistical analysis was performed using the STATISTICA v. 10. Programme for individual areas of physical activity and calculated arithmetic mean values. The non-parametric Mann-Whitney U test and the Kruskal-Wallis tests were used to detect statistically significant differences for quantitative traits. In the case of qualitative features, the structure was presented and the Pearson’s Chi-squared test was used. In all the analyzed cases, the significance level of \( p = 0.05 \) was assumed.

Research results

The research shows the total physical activity as well as the activity within particular areas of life expressed in MET units of officers of two work specializations, i.e. administration and protection, in terms of fitness level, amount of leisure time, self-evaluation of physical fitness, number of performed sports discipline and BMI.

Level of physical activity according to work specialization

The level of total physical activity of protective specialists is higher (-3712.4 MET) than administrative specialists (3439.6 MET), but this difference is not statistically significant (Fig. 1). The statistically significant difference in favour of the protective group was demonstrated in one of the areas, i.e. activity at work.

Free time according to work specialization

The amount of free time does not significantly differentiate both professional specializations. The lack of free time was indicated by a small group of officers, in case of the protective specialization, it was 4.9%, and the administrative, 9.4%. It should be noted that the protective group indicated a sufficient amount of free (60.7%) compared to the administrative group (43.8%) (Fig. 2).
Self-evaluation of physical fitness according to specialization

Self-evaluation of physical fitness level does not significantly differentiate between the two occupational groups. Prison officers assess their fitness level as moderate at best, respectively, 77.1% in the protective specialization and 62.5% in the administrative. On the other hand, the administrative group was more likely to rate its fitness level as high (28.1%) compared to the protective group (18.0%) (Fig. 3).

Number of performed sports disciplines according to specialization

Physical activity was comprised of ranges according to the number of performed sports disciplines. Also, this comparison did not show any significant differences within the analyzed groups of officers, although the occurring differences are noteworthy. The group of administrative employees performed sports less (12.5%) than the protective group (6.6%). Additionally, the number of administrative group representatives performing less than three disciplines (43.8%) is larger than in the protective group (39.3%).

It should be emphasized that the greatest number of sports disciplines are performed by officers of the protective specialization (26.2%) compared to the administrative group (12.5%) (Fig. 4).

BMI according to work specialization

Analysis also did not show statistically significant differences between BMI and work specializations. With similar proper index values of – 16.4% in the protective group and 18.8% in the administrative group, the overweight index is prevalent among all officers. It covers over half of the protective specialization – 65.6%, and 46.9% of the administrative group. It should be highlighted that in the group of administrative officers, as many as 34.4% are obese with a significantly lower index of 18.0% in the protective group (Fig. 5).
Considering that correct body mass index (BMI) should characterize this occupational group, its relationship with physical activity was examined in the officers of both specializations.

**BMI in the protective group and level of physical activity**

Statistical analysis did not show any significant differences in the level of total physical activity or in any of its areas between the BMI categories of the protective group officers. For information purposes, however, it is worth noting that officers with a better BMI score had a level of higher physical activity totalling – 3996.0 MET, overweight – 3789.6 MET, and obese – 3173.6 MET (Fig. 6).

**BMI in the administrative group and the level of physical activity**

Also in the case of administrative officers, statistical analysis did not show statistically significant differences in the level of total physical activity and its areas between persons with normal BMI or those overweight and obese. However, it is worth noting, similarly as in the protective group, that higher levels of total physical activity are characterized by individuals with a more favourable body mass index in the group with a normal index of – 3938.7 MET, overweight – 3512.2 MET, and obese – 3068.3 MET (Fig. 7).

**Discussion**

The importance of the proper level of physical activity is widely appreciated. It is particularly important in many professions, which undoubtedly include prison service officers. The results showing the relatively high total physical activity of the examined officers, both of protective and administrative specialties, which are higher than in other occupational groups (measured with the same tool –
IPAQ), should be acknowledged [3, 26, 27]. The analysis of the factors that differentiate both occupational specializations: leisure time, self-evaluation of physical fitness, number of performed sports disciplines, physical fitness and BMI showed no significant differences, indicating that both groups are similar not only in terms of level of physical activity but also the factors that may condition them. A statistically significant difference was found only in one of the areas of physical activity, i.e. activity at work, in favour of the protective specialization. The obtained results are consistent with the scope of activities performed by the officers of particular groups: administrative – station- ary, typically office work, and protective – related to physical exertion, movement (i.e., escorting, controlling rooms, controlling persons, supervision, etc.).

However, the small number of performed sports disciplines is not particularly favourable in the administrative group. The body mass index (BMI) is considerably less advantageous, which showed overweight officers in the study group, and obesity in over one third of administrative specialists. The analysis of BMI as an important dimension of body condition did not show statistically significant differences in activity level in the protective or administrative specializations. Such results may prove the fact that mainly high awareness of the role of physical activity in performing this profession is an essential factor in their care for the high level of physical activity shown in this study.

Conclusions

1. The officers of both specializations are characterized by high levels of physical activity compared to other professions.
2. The officers perform a small amount of sports disciplines which may be considered as a negative phenomenon.
3. The occurrence of obesity in the administrative specialization should be a signal to implement a change in lifestyle, including greater concern for physical activity and nutrition.
References


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Abstract

Aim. The aim of the study was to acquire knowledge on the contribution of younger school children in organized and non-organized physical activity.

Basic procedures. The main research method was a diagnostic survey. The level of physical activity was determined on the basis of the frequency (number of days per week) and volume (number of hours per week) of organized and non-organized activity. The SPSS 21 (IBM Corp., 2012) programme was used for statistical analysis of the results.

Results. The highest percentage values among the subjects in each age group were recorded in the range of the average level of physical activity. Approximately 2/3 of the subjects in each age group participated in organized physical activity. Almost every third child exercised once a week, the activity lasted one hour. Among the forms of organized physical activity in which children are most likely to participate, those which dominate include: corrective gymnastics, dance and swimming. The vast majority of subjects preferred non-organized physical activity. Daily contact with such activity occurred in the case of about 1/4 of the subjects. Over 1/3 of the participants spent more than 4 hours a week on such activity. Only a few performed this type for 1 hour, and with age, this duration gradually decreased. A typical form of non-organized physical activity was cycling. Games using a ball, other various games, football, roller-skating and swimming were also popular.

Conclusions. The studied participants were more likely to perform non-organized forms of movement than those organized. In addition to physical activity, quite a large percentage of the surveyed children spent their free time in front of the TV or playing computer games. Along with the increase in age, there was a rise in the interest in tennis, football and computer games, and there was less interest in skiing or playing games.

Introduction

At every stage of ontogenetic development, physical activity plays a very important role. It affects not only somatic development and physical fitness of the system, but it also strengthens the nervous system, increases mental ability and slows cognitive decline [1]. Performed systematically, it brings many health benefits. But to achieve long-term effects, daily or almost daily exercise is recommended [2]. Considering the developmental needs of children and adolescents aged 5 to 18, it is recommended that daily physical exercise of moderate intensity be performed for at least 60 minutes a day [3, 4, 1]. The required level of physical activity during childhood, as well as positive experiences, create the opportunity for life-long contact with all forms of movement. In turn, lack of movement in childhood can determine this activity in adult life. Therefore, physical activity, due to its merits, should occupy a priority place in the everyday functioning of a human being from a young age.
School-aged children can participate in both school and extracurricular physical activity in organized or non-organized forms. Organized physical activity involves participation in physical education classes, corrective gymnastics classes and sports club training. These classes are conducted by a teacher, instructor or coach, or another person authorized by the instructor. On the other hand, non-organized physical activity is undertaken by children voluntarily and most often takes place in the form of fun and games related to movement, organized without any pedagogical scheme or supervision [5].

Organized school physical activity can be seen in terms of participation in compulsory physical education provided for all pupils, non-compulsory corrective-compensational gymnastics classes that are organized for pupils with postural disabilities and non-compulsory extra-curricular activities addressed mainly to pupils who show predisposition and interest in additional forms of movement. Of the listed opportunities for participation in school physical activity, only compulsory physical education is an integral part of physical education in early school education. The quality of these activities influences the preparation of the child for later participation in physical activity during their free time.

The main purpose of this study was to identify the participation of children at a school age in organized and non-organized physical activity. The study was meant to provide answers to the posed detailed research questions:
1. What is the level and content of organized and non-structured physical activity of school-children?
2. How do the studied children usually spend their free time?
3. Are there variations in the tested variables depending on the age of the children?

Material and methods

The study involved 1,055 randomly selected primary school children from elementary schools operating in an urban environment. The territorial location of the selected schools comprised of 14 (78%) of the 18 districts of Kraków. From the total of the subjects to the final analysis, 334 students aged 7-8 years (32.9%), 365 aged 8-9 years (35.9%) and 317 aged 9-10 years (31.2%) were qualified for the study.

The basic research method was a diagnostic survey. Since conducting this type of research in this age group is extremely difficult, the survey technique was used to obtain the necessary information and data, with an original survey questionnaire that is in accordance with the methodology required for verification of pilot studies. The pilot was primarily concerned with the typological representativeness of the group, which is similar in terms of age, gender and education, relative to the proper group. This group did not constitute the population for research proper.

The aim of the pilot was to check whether the participants correctly understood all of the posed questions, whether the instructions were clear, indicate whether there were missing answers (such a situation could be suggested, for example, by the respondents’ adding written information).

The level of physical activity of 7-10 year-olds was determined on the basis of frequency (number of days per week) and volume (number of hours per week) of organized and non-organized physical activity. The subjects were also asked about the most common forms of movement in both cases, and how they spend their free time. In total, the student was able to obtain from 0 to 22 points, which was the basis for establishing five numerical ranges: very low below 4, low 4-8, moderate 9-13, high 14-18 and very high 19-22 pts.

The Statistics SPSS 21 (IBM Corp., 2012) programme was used for statistical analysis of the study results. A description of the qualitative data was provided by means of a compilation of numbers and percentages. In contrast, the Chi-squared test was used to examine the relationship between qualitative data. In turn, the analysis of the correlation between the estimated variables (ordering variables - age of students) with quantitative or quantitative variables, Spearman’s rank correlation coefficient was used to analyze nonparametric correlations [6]. Statistically significant correlations were assumed at the level of $p < 0.05$, marked by one asterisk, and at $p < 0.01$ by two asterisks.

Results

According to the calculations provided in Table 1, the highest percentages among the subjects in each age group were recorded in the range of the average level of physical activity. The very high level of this activity was noted in only about 4% of children. The average level of motor activity was highest in the 8-9 year age group (43.3%) and the lowest in the 9-10 age group (36.9%). In the very low-level range, the largest group consisted of 9-10 year-old female and male pupils. There was no statistically significant relationship between the age and physical activity levels of the subjects.

Approximately 2/3 of the subjects in each age group participated in organized physical activity. This means that more than 1/3 of the children did not take part in organized motor activities at all (Tab. 2). Almost every third child exercised once a week, and the activity lasted one hour. The lowest proportion of subjects participated in motor activities more than three times a week. Among the study groups, the best results were seen among children aged 8-9 years, both in the frequency of physical activity per week and in intensity regarding the number of
Table 1. Level of subjects’ physical activity

<table>
<thead>
<tr>
<th>Level of physical activity</th>
<th>Age</th>
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<td></td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td>7-8 years</td>
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<tr>
<td>Very low</td>
<td>60</td>
<td>17.9</td>
<td>56</td>
<td>15.3</td>
<td>63</td>
<td>19.9</td>
<td>17.9</td>
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<tr>
<td>Low</td>
<td>62</td>
<td>18.6</td>
<td>59</td>
<td>16.2</td>
<td>53</td>
<td>16.7</td>
<td>18.6</td>
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<tr>
<td>Moderate</td>
<td>129</td>
<td>38.6</td>
<td>158</td>
<td>43.3</td>
<td>117</td>
<td>36.9</td>
<td>38.6</td>
</tr>
<tr>
<td>High</td>
<td>74</td>
<td>22.2</td>
<td>71</td>
<td>19.4</td>
<td>72</td>
<td>22.7</td>
<td>22.2</td>
</tr>
<tr>
<td>Very high</td>
<td>9</td>
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<td>21</td>
<td>5.8</td>
<td>12</td>
<td>3.8</td>
<td>2.7</td>
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<tr>
<td>Total</td>
<td>334</td>
<td>100</td>
<td>365</td>
<td>100</td>
<td>317</td>
<td>100</td>
<td>100</td>
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</tbody>
</table>

Correlation: \( \chi^2(8) = 9.82; p = 0.293 \)

Table 2. Frequency and volume of organized physical activity

<table>
<thead>
<tr>
<th>Organized physical activity</th>
<th>Age</th>
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<th></th>
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<th>Spearman’s rho correlation</th>
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<tr>
<td></td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
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<tr>
<td>Frequency per week</td>
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<td></td>
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<tr>
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<td>119</td>
<td>35.6</td>
<td>129</td>
<td>35.3</td>
<td>123</td>
<td>38.8</td>
<td>35.6</td>
<td>129</td>
</tr>
<tr>
<td>Once</td>
<td>121</td>
<td>36.2</td>
<td>111</td>
<td>30.4</td>
<td>112</td>
<td>35.3</td>
<td>36.2</td>
<td>111</td>
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<tr>
<td>Twice</td>
<td>65</td>
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<td>78</td>
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<td>59</td>
<td>18.6</td>
<td>19.5</td>
<td>78</td>
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<tr>
<td>Three times</td>
<td>19</td>
<td>5.7</td>
<td>32</td>
<td>8.8</td>
<td>14</td>
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<td>5.7</td>
<td>32</td>
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<td>Above three</td>
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<td>9</td>
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<td>15</td>
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<tr>
<td>Number of hours per week</td>
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<td>38.8</td>
<td>35.6</td>
<td>129</td>
</tr>
<tr>
<td>1 h.</td>
<td>113</td>
<td>33.8</td>
<td>100</td>
<td>27.4</td>
<td>104</td>
<td>32.8</td>
<td>33.8</td>
<td>100</td>
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<td>2 h.</td>
<td>55</td>
<td>16.5</td>
<td>55</td>
<td>15.1</td>
<td>48</td>
<td>15.2</td>
<td>16.5</td>
<td>55</td>
</tr>
<tr>
<td>3 h.</td>
<td>28</td>
<td>8.4</td>
<td>29</td>
<td>8.0</td>
<td>20</td>
<td>6.3</td>
<td>8.4</td>
<td>29</td>
</tr>
<tr>
<td>4 h.</td>
<td>12</td>
<td>3.6</td>
<td>26</td>
<td>7.1</td>
<td>8</td>
<td>2.5</td>
<td>3.6</td>
<td>26</td>
</tr>
<tr>
<td>Above 4 h.</td>
<td>7</td>
<td>2.1</td>
<td>26</td>
<td>7.1</td>
<td>14</td>
<td>4.4</td>
<td>2.1</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>334</td>
<td>100</td>
<td>365</td>
<td>100</td>
<td>317</td>
<td>100</td>
<td>100</td>
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</tr>
</tbody>
</table>

Table 3. Most frequently performed forms of organized physical activity

<table>
<thead>
<tr>
<th>Forms of organized physical activity</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
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<th>Spearman’s rho correlation</th>
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<tr>
<td></td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td></td>
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<tr>
<td>Corrective gymnastics</td>
<td>154</td>
<td>71.6</td>
<td>151</td>
<td>63.9</td>
<td>128</td>
<td>65.9</td>
<td>71.6</td>
<td>151</td>
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<tr>
<td>Dance</td>
<td>35</td>
<td>16.3</td>
<td>47</td>
<td>19.9</td>
<td>23</td>
<td>11.9</td>
<td>16.3</td>
<td>47</td>
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<tr>
<td>Swimming</td>
<td>30</td>
<td>13.9</td>
<td>32</td>
<td>13.6</td>
<td>32</td>
<td>16.5</td>
<td>13.9</td>
<td>32</td>
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<td>Football</td>
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<td>6.1</td>
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<td>11.9</td>
<td>16</td>
<td>8.3</td>
<td>6.1</td>
<td>28</td>
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<tr>
<td>Martial arts</td>
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<td>7.9</td>
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<td>8.5</td>
<td>11</td>
<td>5.6</td>
<td>7.9</td>
<td>20</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>9</td>
<td>4.2</td>
<td>9</td>
<td>3.8</td>
<td>8</td>
<td>4.1</td>
<td>4.2</td>
<td>9</td>
</tr>
<tr>
<td>Tennis</td>
<td>4</td>
<td>1.9</td>
<td>6</td>
<td>2.5</td>
<td>6</td>
<td>3.1</td>
<td>1.9</td>
<td>6</td>
</tr>
<tr>
<td>Basketball</td>
<td>0</td>
<td>0.0</td>
<td>5</td>
<td>2.1</td>
<td>7</td>
<td>3.6</td>
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<td>Other</td>
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<td>4.2</td>
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<td>4.2</td>
<td>15</td>
</tr>
</tbody>
</table>

**: p < 0.01

Note: the percentages do not add up to 100 because the subjects could indicate more than one form.
hours per week. Differences between age groups in the analyzed indices were not statistically significant.

The research was also conducted to show in what types of physical activity children usually participated. After ordering the mentioned forms of physical activity in the questionnaire, eight of them were selected (Tab. 3). The forms of activity which occurred sporadically were included in other groups such as track-and-field, table tennis, acrobatics, rhythmic, horse-riding, badminton, ballet, volleyball, etc. Among the forms of organized physical activity in which children were most often involved, corrective gymnastics dominated, regardless of the subjects’ age. Here, it should be emphasized that for the children diagnosed with postural defects using specialized tests, corrective gymnastics is a must. Hence, this shows the great advantage of corrective gymnastics over other forms of activity. It also turned out that dancing and swimming were popular sports in all age groups. Football and martial arts also assumed a high position. Along with age, there was a rise in the interest in basketball, and this relationship was statistically significant at \( p < 0.01 \).

Almost 2/3 of the children attended organized school activities (Tab. 4). These were mainly corrective gymnastics classes, organized as extracurricular activities. However, school was not the only place where children participated in such activities. Some students attended corrective gymnastics classes at other institutions. Outside of school, the students went to sports clubs, houses of culture, youth centres and other locations.

The age of the subjects was not significant when choosing a facility that is a place for children to participate in organized motor activities, although the greatest variation in age-group percentages occurred in the case of sports clubs.

In addition to obtaining information about the participation of younger school children in organized physical activity, an attempt was made to determine the scale of non-organized forms of movement. The analysis of data presented in Tab. 5 shows that the vast majority of the subjects (about 80%) preferred non-organized physical activity. Daily contact with such activity was reported by about 1/4 of the participants, and at a frequency of at least

### Table 4. Places of children’s participation in organized motor-ability classes

<table>
<thead>
<tr>
<th>Place of participation in organized motor classes</th>
<th>7-8 years</th>
<th>8-9 years</th>
<th>9-10 years</th>
<th>Spearman’s rho correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>School</td>
<td>158</td>
<td>73.5</td>
<td>168</td>
<td>71.2</td>
</tr>
<tr>
<td>Sports club</td>
<td>51</td>
<td>23.7</td>
<td>78</td>
<td>33.1</td>
</tr>
<tr>
<td>House of culture</td>
<td>28</td>
<td>13.0</td>
<td>25</td>
<td>10.6</td>
</tr>
<tr>
<td>Youth club</td>
<td>3</td>
<td>1.4</td>
<td>5</td>
<td>2.1</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>3.3</td>
<td>7</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Note: the percentages do not add up to 100 because the subjects could indicate more than one place.

### Table 5. Frequency and volume of non-organized physical activity

<table>
<thead>
<tr>
<th>Non-organized physical activity</th>
<th>7-8 years</th>
<th>8-9 years</th>
<th>9-10 years</th>
<th>Spearman’s rho correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Frequency per week</td>
<td></td>
<td></td>
<td></td>
<td>-0.01</td>
</tr>
<tr>
<td>None</td>
<td>68</td>
<td>20.3</td>
<td>76</td>
<td>20.8</td>
</tr>
<tr>
<td>Once</td>
<td>21</td>
<td>6.3</td>
<td>30</td>
<td>8.2</td>
</tr>
<tr>
<td>Twice</td>
<td>44</td>
<td>13.2</td>
<td>42</td>
<td>11.5</td>
</tr>
<tr>
<td>Three times</td>
<td>35</td>
<td>10.5</td>
<td>48</td>
<td>13.2</td>
</tr>
<tr>
<td>Four times</td>
<td>32</td>
<td>9.6</td>
<td>31</td>
<td>8.5</td>
</tr>
<tr>
<td>Above four</td>
<td>52</td>
<td>15.6</td>
<td>52</td>
<td>14.2</td>
</tr>
<tr>
<td>Every day</td>
<td>82</td>
<td>24.5</td>
<td>86</td>
<td>23.6</td>
</tr>
<tr>
<td>Number of hours per week</td>
<td></td>
<td></td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>None</td>
<td>68</td>
<td>20.3</td>
<td>76</td>
<td>20.8</td>
</tr>
<tr>
<td>1 h.</td>
<td>20</td>
<td>6.0</td>
<td>20</td>
<td>5.5</td>
</tr>
<tr>
<td>2 h.</td>
<td>51</td>
<td>15.3</td>
<td>56</td>
<td>15.3</td>
</tr>
<tr>
<td>3 h.</td>
<td>40</td>
<td>11.9</td>
<td>40</td>
<td>11.0</td>
</tr>
<tr>
<td>4 h.</td>
<td>31</td>
<td>9.4</td>
<td>45</td>
<td>12.3</td>
</tr>
<tr>
<td>Above 4 h.</td>
<td>124</td>
<td>37.1</td>
<td>128</td>
<td>35.1</td>
</tr>
<tr>
<td>Total</td>
<td>334</td>
<td>100</td>
<td>365</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 6. Most frequently performed forms of non-organized physical activity

<table>
<thead>
<tr>
<th>Forms of non-organized physical activity</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
<th>Spearman’s rho correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Cycling</td>
<td>201</td>
<td>75.6</td>
<td>212</td>
<td>74.4</td>
<td>174</td>
</tr>
<tr>
<td>Fun and games using a ball</td>
<td>74</td>
<td>27.8</td>
<td>73</td>
<td>25.2</td>
<td>73</td>
</tr>
<tr>
<td>Games</td>
<td>59</td>
<td>22.2</td>
<td>64</td>
<td>22.2</td>
<td>57</td>
</tr>
<tr>
<td>Football</td>
<td>40</td>
<td>15.0</td>
<td>66</td>
<td>22.8</td>
<td>52</td>
</tr>
<tr>
<td>Roller-skating</td>
<td>45</td>
<td>16.9</td>
<td>48</td>
<td>16.6</td>
<td>60</td>
</tr>
<tr>
<td>Swimming</td>
<td>35</td>
<td>13.2</td>
<td>37</td>
<td>12.8</td>
<td>27</td>
</tr>
<tr>
<td>Skiing</td>
<td>35</td>
<td>13.2</td>
<td>28</td>
<td>9.7</td>
<td>19</td>
</tr>
<tr>
<td>Running</td>
<td>19</td>
<td>7.1</td>
<td>15</td>
<td>5.2</td>
<td>19</td>
</tr>
<tr>
<td>Walking</td>
<td>23</td>
<td>8.7</td>
<td>15</td>
<td>5.2</td>
<td>14</td>
</tr>
<tr>
<td>Scootering</td>
<td>12</td>
<td>4.5</td>
<td>13</td>
<td>4.5</td>
<td>13</td>
</tr>
<tr>
<td>Ice-skating</td>
<td>6</td>
<td>3.0</td>
<td>10</td>
<td>3.5</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>28</td>
<td>10.5</td>
<td>35</td>
<td>12.1</td>
<td>29</td>
</tr>
</tbody>
</table>

*: p < 0.05
Note: the percentages do not add up to 100 because the subjects could indicate more than one form

Table 7. Children’s forms of spending free time in the opinion of parents

<table>
<thead>
<tr>
<th>Forms of spending free time</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
<th>Spearman’s rho correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Cycling</td>
<td>256</td>
<td>76.7</td>
<td>259</td>
<td>70.9</td>
<td>237</td>
</tr>
<tr>
<td>Playing outside</td>
<td>253</td>
<td>75.8</td>
<td>233</td>
<td>63.8</td>
<td>238</td>
</tr>
<tr>
<td>Playing football</td>
<td>152</td>
<td>45.5</td>
<td>163</td>
<td>44.7</td>
<td>173</td>
</tr>
<tr>
<td>Watching TV</td>
<td>138</td>
<td>41.3</td>
<td>144</td>
<td>39.5</td>
<td>128</td>
</tr>
<tr>
<td>Playing the computer</td>
<td>114</td>
<td>34.1</td>
<td>136</td>
<td>37.3</td>
<td>143</td>
</tr>
<tr>
<td>Reading books</td>
<td>102</td>
<td>30.5</td>
<td>122</td>
<td>33.4</td>
<td>99</td>
</tr>
<tr>
<td>Other</td>
<td>52</td>
<td>15.6</td>
<td>57</td>
<td>15.6</td>
<td>44</td>
</tr>
</tbody>
</table>

**: p < 0.01
Note: the percentages do not add up to 100 because the subjects could indicate more than one form

Table 8. Children’s forms of spending free time in their own opinion

<table>
<thead>
<tr>
<th>Forms of spending free time</th>
<th>Age</th>
<th></th>
<th></th>
<th></th>
<th>Spearman’s rho correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7-8 years</td>
<td>8-9 years</td>
<td>9-10 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Playing computer games</td>
<td>192</td>
<td>57.5</td>
<td>223</td>
<td>61.1</td>
<td>229</td>
</tr>
<tr>
<td>Playing football</td>
<td>161</td>
<td>48.2</td>
<td>204</td>
<td>55.9</td>
<td>187</td>
</tr>
<tr>
<td>Watching TV</td>
<td>186</td>
<td>55.7</td>
<td>184</td>
<td>50.4</td>
<td>179</td>
</tr>
<tr>
<td>Reading books</td>
<td>128</td>
<td>38.3</td>
<td>174</td>
<td>47.7</td>
<td>140</td>
</tr>
<tr>
<td>Games</td>
<td>60</td>
<td>18.0</td>
<td>47</td>
<td>12.9</td>
<td>25</td>
</tr>
</tbody>
</table>

**: p < 0.01
Note: the percentages do not add up to 100 because the subjects could indicate more than one form
once a week: 6.3% of children aged 7-8; 8.2% aged 8-9 and 6% aged 9-10 years. The number of hours children spent on unstructured forms of movement during the week was varied. Over 1/3 of the subjects dedicated more than 4 hours to this activity. Only a few practiced 1 hour, and with age, this gradually decreased. The age of the subjects only slightly differentiated physical activity in the analyzed dimensions and was not statistically significant.

Research revealed differentiation in children’s interest in non-organized forms of physical activity (Tab. 6). Based on information obtained from parents, it was found that for the majority of children at a younger school age, a typical form of non-organized physical activity was cycling. Although with age, interest in this form of movement gradually decreased (75.6%, 74.4%, 71.2%, respectively). Fun and games using a ball, other various games, football, roller-skating and swimming were also popular. During winter, children also skied. Other forms of movement included horse-riding, badminton, tennis, sledding, roller-skating, skateboarding, etc. What requires explanation is that some of the participants took part in several forms of physical activity at the same time. When analyzing the results obtained among different age groups, there was a distinct difference in only one form of physical activity. With age, the interest in skiing decreased. This decrease was statistically significant at $p < 0.01$.

When obtaining multidirectional information on children’s physical activity, parents were asked an additional question: How does your child usually spend his/her free time? In this manner, we obtain information determining what place physical activity assumes among other forms of leisure time activities for 7-10 year olds. The results of the study confirmed the predominant role of physical activity (Tab. 7). Most frequently, the children rode a bike, played with their peers in the yard and played football. However, about 40% of the studied subjects watched television and over 1/3 played computer games during their free time. Only one in every three subjects read a book during their free time. Other forms of indicated leisure time activities included: playing with siblings at home, walking, roller-skating, corrective gymnastics, drawing, making models, DIY, listening to music, playing instruments, being a scout, solving crossword puzzles, etc. The results showed that interest in playing football and computer games increased with age, and these relationships were statistically significant at $p < 0.01$.

This study was supplemented by a comparison of parents’ views on the free time spent by children at an early school age, with the opinions of the children themselves. Comparing the results of the study on children with parents’ opinions, it was found that in the case of some forms of free time activities, tendencies remained, apart from the difference in percentage values (Tab. 8). Similarly as in the opinions of parents, along with age, interest in computer games and football increased, while participation in various games decreased. The above age-related dependencies were statistically significant at $p < 0.01$.

**Discussion**

From the conducted research it can be concluded that the level of physical activity in most children aged 7-10 years was in the middle range. The fact that about 1/3 of the subjects reported low and very low levels of physical activity is quiet disturbing. This is at the least - puzzling, because to some extent, it contradicts the development of the ontogenetic internal need for movement in children during this period. These concerns are all the more justified because, as it is well known, physical activity is the basis for a correct child’s comprehensive development. And the proper amount of movement improves a child’s concentration, which undoubtedly has a better effect on learning [7-9]. Similar trends have been reported in physical activity tests on American children in a comparable age group, where 37.3% were less active (less than 6 times a week), and most of their leisure time was spent watching television [10].

Based on the results, almost 2/3 participated in organized physical activity (at schools, sports clubs, houses of culture). Among this group of children, slightly more than 30% exercised once a week, and spent 1 hour on this activity. In comparison, 76.8% of 11-year-olds attended non-school classes (sports clubs, etc.) in Belgium. On the other hand, 75.9% of children participated in extra-curricular activities, of which, 43.5% exercised about 1 hour, and 31.8% over 1 hour a week [11]. In Luxembourg, 52% of nine-year-olds practiced sports at sports clubs – including 65% of boys and 39% of girls [12]. Moreover, 63% of Irish primary school students took part in extra-curricular sports. Although the recommended level of physical activity at 1 hour per day was practiced by only 27% of male students and 13% of female students [13], a slightly lower percentage of children were interested in this form of activity at Greek schools. 48.9% of boys and 31.8% of girls were involved in out-of-school sports activities, and at least 3 hours a week is devoted to this activity [14]. Research conducted in Germany among 10-year-olds showed that sports were performed by 27.9% of boys and 38.5% of girls, 1-2 times a week, and by 56.9% of boys and 38.2% of girls 3-4 times a week [15]. In our research, apart from gymnastics, the most popular forms of organized physical activity were: dance and swimming, similarly as in Switzerland [16].

The vast majority of the studied children (about 80%) preferred non-organized physical activity. Daily contact with such activity was reported by about 1/4 of the subjects, and more than 1/3 devoted above 4 hours a week.
to such a form of movement. The percentage of children engaged in non-organized free-time activity is comparable in Luxembourg (74%) [12], and slightly lower in Germany (about 60% - 2.5 hours per week) [17]. Both in Poland and Luxembourg as well as Germany and Switzerland, cycling is a popular form of leisure time activity [12, 16, 17].

Playing computer games and watching television dominated the other forms of free time activities. Unfortunately, as the study showed, interest in computer games increased along with the age of children, where in the group of 9-10 year-olds, the percentage was as high as 72.2%. A similar tendency was noted in the study on younger students from a rural environment [18].

Conclusions

1. In general, the level of physical activity of children aged 7-10 years was moderate. The study participants performed non-organized physical activity more often than organized forms.

2. In addition to physical activity, quite a large proportion of the surveyed children spent their free time watching TV or playing computer games.

3. In almost all of the analyzed areas, differentiation of the studied variables was dependent on the age of the children. At the level of statistical significance, interest in tennis, football and computer games increased along with age, while there was a decrease regarding interest in skiing and playing games.

References


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Phone number: +48 696 034 975
Associate Professor Doctor Maciej Demel, M.D., Ph.D., – an outstanding scholar and eruditist with polyvalent education. Graduate of Stefan Batory Junior High and High School in Warsaw; graduate of three faculties: M.A. in Physical Education (1948) and Pedagogy (1949) at the Jagiellonian University in Krakow and Medical Doctor degree from the Medical Academy in Lublin (1952). He received his doctorate in teaching sciences at the University of Warsaw in 1962, and a postdoctoral degree in humanities in the field of the theory of physical education in 1965, also at the University of Warsaw. In 1971, he became the first professor in our country, and eight years later, he became a professor of physical education. In 1993, Professor was awarded the Honoris Causa title of Doctor of Physical Education from the University of Physical Education in Krakow.

In the years 1942 to 1945, as an educator, he took part in underground teaching. After the war, he worked as a physical education teacher, recreation and rehabilitation worker, school physician. He was a lecturer at Maria Curie-Skłodowska University and the Medical Academy in Lublin, the Higher School of Physical Education.
in Krakow and Poznan, the Higher School of Pedagogy in Kielce and the University of Warsaw. In the years 1953-
1970, he worked at the Institute of Physical Culture, and
from 1970 to 1992, as a professor at the Academy of
Physical Education in Warsaw.

Professor’s closeness to Bielany reached – as he
wrote - the times before construction of the Central
Institute of Physical Education (CIWF), when as a child he
spent much time in the Bielany Forest and in the area of
the future Univeristy of Physical Education. As the son of
a 1st Brigade legionary – expressive memories connect-
ed him to the patron of our University – Marshall Józef
Piłsudski. Fate caused him to study physical education
at the Jagiellonian University in Krakow, but over forty
years of work linked him to Warsaw AWF.

In his publication on the achievements of the Acad-
emy of Physical Education (1989), Ryszard Przewęda
writes that in the history of the Warsaw School there are
three characters who, in the development of the Polish
theory of physical education, have played an out-
standing and permanent role in its development. These are
Władysław Osmolski, Zygmunt Gilewicz and Maciej De-
mel. I fully share this view. Here, it should be added that
against the background of the first two outlined charac-
ters, Maciej Demel’s scientific work distinguishes itself
in that it concerns not only physical education. It con-
sists of three distinct cognitive but subordinated com-
mon axiological contents: physical education theory,
health pedagogy and the history of hygienic and social
medicine.

In the field of physical education theory – Henryk
Grabowski writes in his laudation (1993) – that Professor
Maciej Demel was one of the most outstanding creators
in the history of this discipline, the initiation launched
by Jędrzej Śniadecki, the analysis conducted by Euge-
niusz Piasecki, and synthesized by Zygmunt Gilewicz;
and reapedudized by Demel. His completely original
concept of physical education, described and developed
in numerous publications for over 40 years, is usually
referred to as a revolution in the Polish theory of physical
education. Professor Maciej Demel also undertook an
extraordinary effort to translate the humanistic version
of physical education theory into the language of practi-
cal activities, giving the process of physical education
a structure based on the achievements of praxeology.
His links in this process are arranged in a methodologi-
cal manner of action, creating protection against educa-
tional mistakes.

According to Maciej Demel, the subject of education
cannot be the body but only the personality of a pupil.
This reinstitution brought back the physical education of
pedagogics, led to the reintegration of physical educa-
tion with education, without losing its specific nature.
This was a change in the axiology and teleology of physi-
cal education. From Demel, the concept of education for
physical culture has been broadly adopted, and empha-
sis was placed on far-reaching physical education goals
rather than its ad hoc functions. This innovative look at
physical education, as a process of preparing young
people for later participation in physical culture, was re-
lected not only in numerous dissertations and articles,
but also in monographs and academic textbooks. These
include: Propedeutyka wychowania fizycznego [Prope-
deutics of Physical Education] (1965), Teoria wychow-
ania fizycznego dla pedagogów [Theor y of Physical Ed-
ucation for Educators] (1970, co-author: Alicja Sklad),
Szkice krytyczne o kulturze fizycznej [Critical Outlines on
Physical Culture] (1973), O trzech wersjach teorii wy-
chowania fizycznego [On the Three Versions of Physical
kulturze fizycznej, o zdrowiu i wychowaniu [Repeti-
tions. Selected Opinions on Physical Culture, Health and

If we assume that in the Polish theory of physical
education Professor Maciej Demel has made significant
transformations, then pedagogy of health, understood as
the theoretical basis of health education - according to
Henryk Grabowski – was created from the ground up.
In many works in this field, and especially in two books:
On Health Education (1968) and Pedagogy of Health
(1980), it is presented as a new discipline by pointing
out the genesis, creating a theory, defining and ordering
terminology and proposing classification. In Maciej De-
mel’s view, health education, drawing on the content of
medicine and the form of pedagogy, creates a bridge be-
 tween the world of nature and culture, combining the
humanities with human biology into a harmonious whole.

For Prof. Maciej Demel, historical research was al-
ways the source of inspiration for creative proposals
in the field of physical and health education, which he
claimed to treat not only as a source of often up-to-date
ideas, but also as a school of progressive mechanisms
and the art of prognostic thinking. Respect for indige-
nous traditions and excellent historical workshops have
made him the most knowledgeable person in the history
of hygiene and social medicine in Poland. The crowning
of writing achievements in this area is the comprehen-
sively documented book titled Księga tradycji Polskiego
Towarzystwa Higienicznego [The Book of Traditions of
the Polish Hygienic Society], published in 1991. It is ad-
ditionally worth noting that Professor Maciej Demel was
also the most distinguished expert and interpreter of
Jędrzej Śniadecki’s works in our country. He expressed
this in numerous publications. He was also a critical
journalist and scientific satirist, but – as he himself wrote
– he abandoned this due to lack of proper response.

From this brief account of Professor Maciej Demel’s
achievements, thanks to comprehensive knowledge in

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the fields of physical education, pedagogy, medicine and history, the image of a scholar emerges who has the ability to integrate and create new disciplines. The numerous group of Professor Maciej Demel’s pupils is not limited to the nominal representatives of his major scientific disciplines: the theory of physical education and health pedagogy. It includes all of those who have widely used and continue to use the wealth of his intellectual and methodological achievements in solving their own research problems, and also use the original conceptual apparatus developed by Professor. This applies to the entire academic community of physical education, teaching and university colleges, as well as to a large number of medical professionals. What makes him the unparalleled model of the Master for many generations of adepts of the scientific research art is the extraordinary reliability of his scientific workshop and the culture as well as the authentic modesty that among others, manifests itself in the full respect for his work by following generations. He is also especially distinguished by his sense of responsibility for the spoken or written word.

For his accomplishments, he has been decorated with numerous awards, including the Order of Polonia Restituta, the Medal of the National Education Commission, the Gold Badge for Meritorious Physical Culture Activist, the Golden Badge of the Polish Educators’ Union for underground teaching and the Janusz Korczak Gold Medal. He was an Honorary Member of the Polish Hygienic Society, a laureate of the Marcin Kacprzak Award. In 2009, he was awarded a Medal for Merits at the Józef Piłsudski University of Physical Education in Warsaw.

Professor Maciej Demel’s personality was one of extraordinariness: the highest of erudites and versatile scholar – the creator of modern concepts of physical and health education, paving new routes for the sciences of physical culture, resonating from Warsaw University to other academic centres in Poland and abroad.

Towards the end, a pinch of personal reflection. I admire Prof. Maciej Demel’s work: scientific creativity, educational activity and devotion to physical and health culture. And I will always remember our long-term editorial cooperation at the magazine “Wychowanie Fizyczne i Zdrowotne” [Physical and Health Education]. As a long-term Chairman of the Editorial Board and Author of leading texts, Professor has multiplied the content and cultural sensitivity to message. I am convinced that the academic achievements and creative pedagogical achievements of Professor and his memory will not fade, because they are permanently integrated into the landscape of Polish science and in the minds and hearts of his students, co-workers and friends.

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* The following sources were used in this text: M. Demel, Repetycje. Wybrane zdania o kulturze fizycznej, o zdrowiu i wychowaniu [Repetitions. Selected Opinions on Physical Culture, Health and Education], Warsaw 2008; T. Maszczak, Kierunki rozwoju Katedry Teorii i Metodyki Wychowania Fizycznego w warszawskiej AWF. Roczniki Naukowe AWF w Warszawie [The Direction in the Development of the Physical Education Theory and Methodology Department. AWF Warsaw Scientific Yearbooks], 2001, Volume XL; Professor Maciej Demel. Honoris causa Doctor of the University of Physical Education in Krakow, Krakow 1993; R. Przewęda, Dorobek teorii wychowania fizycznego i wychowania zdrowotnego w warszawskiej AWF, Roczniki Naukowe AWF w Warszawie [Achievements in the Theory of Physical and Health Education at the Warsaw AWF; AWF Warsaw Scientific Yearbooks], 1989, Volume XXXII; photograph – Mariola Godlewska.
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