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WHO recommendations on physical activity vs. compliance rate within a mid-sized, Central-European city

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ABSTRACT

Objective: The study addressed the three key areas: evaluation of overall level of physical activity in the residents of a mid-sized, Central-European city, compliance level with World Health Organization's (WHO) recommendations on physical activity in leisure time, and actual impact of select socio-economic factors within the study population.

Methods: Assessment of the source data collected for 4,619 residents (1,532 men and 3,087 women, aged 45-65; mean age 56.41±5.31 years) was completed. Three levels of physical activity, and compliance level with pertinent WHO recommendations was evaluated, based on *IPAQ (long form)*. Multilevel logistic regression models of socio-economic factors associated with moderate-, high-level physical activity, and WHO recommendations were developed; the results tabularised as the odds ratios (OR), and 95% confidence intervals (CI).

Results: Data analyses revealed that 6.19% of the study subjects (n=286) engaged in low-level physical activity, 48.86% (n=2,257) - in moderate-level activity, while high-level activity was reported in 44.94% (n=2,076) of them. Compliance with pertinent WHO recommendations was higher in men aged 44-55, boasting upper-level education, living without a partner, and in the persons with a net income over €1,140 per household.

Conclusions: Overall level of physical activity in the residents of a mid-sized, Central-European city was established as moderate. Pertinent WHO recommendations on physical activity were met by 4.2% of the subjects only. Global epidemic of chronic, non-infectious diseases is believed to be directly tied to the on-going changes in lifestyle, including appreciably reduced physical activity, especially during leisure time.

Key words: physical activity, leisure time, WHO recommendations, public health, physically active lifestyle

Trial registration: Not required, as the study design envisaged no health interventions whatsoever.

Strengths and limitations of this study

- Select socio-economic factors, widely established to account for the populations' lifestyles in respective localities, are found to be directly causative in determining the actual level of self-admitted, individually pursued physical activity.
- Furthermore, addressing individual deficits in physical activity, when done in consideration of WHO recommendations currently in place, is deemed to be in urgent need of adequate upgrading to effectively account for a diversity of on-going changes in respective populations' lifestyles.
- Several specific findings of the study, granted extra credence by having been sourced from an over 4,600-strong population, boast substantial application potential as nationwide public health policy pointers in terms of prioritizing.
- The study protocol did not provide for a verification of an individual physical activity through objective assessment methods (e.g. accelerometer, pedometer).
- Nor did it envisage a follow-up, hence no opportunity for establishing whether the very fact of addressing the survey questionnaire by the respondents may have in any way affected their individual lifestyles, e.g. encourage them to take up any type of regular physical activity.

Introduction

Lack of physical activity in conjunction with sedentary lifestyle are deemed by far the most hazardous to any modern-day population[1,2,3,4,5,6] . If physical activity is to offer any beneficial effects whatsoever, certain key criteria must be complied with, e.g. frequency and intensity. Physical activity should be approached comprehensively in terms of actual exertion in different areas of everyday life, i.e. at work, at home, while travelling or commuting, and in leisure time[1]. Assessment of physical activity level helps making viable predictions on individual health status. It also plays an essential role in promoting one's physical and mental wellbeing, as well as public health at large[2].

On-going evolution of individual lifestyles is invariably shaped by changes occurring within human environment. Civilisational progress and attendant technological advances in all areas of life have contributed to an appreciable reduction in physical activity. Overall deficiency in physical activity associated with a diversity of modern conveniences commonly available in everyday life has serious implications for human health status. Lack of regular physical activity contributes to the development of chronic diseases, e.g. cardiovascular diseases, metabolic disorders, cancer, respiratory diseases, musculoskeletal disorders, neurological diseases[3–8].

Physical activity is vital for retaining good health, shaping health-promoting behaviour, as well as a valuable option for spending leisure time. Lack of physical activity in a population may prove instrumental in placing an appreciable burden on both national economy and public health care system, primarily by way of appreciably increasing expenditure on the health care services for the individuals unfit to work. Much wider appreciation of an essential role physical activity plays in

prevention and treatment of civilizational diseases has prompted an increased interest in the physically active dimension of life.

Even though beneficial effects of physical activity are widely acknowledged, more than 30% of adults in Europe seldom get involved in any physical exercise regimens[9]. According to WHO, any physical activity is better than none at all, with the benefits largely independent of sex, race, or ethnicity[10,11]. WHO recommends that healthy adults aged 18-64 years should engage in moderate-intensity physical activity for at least 150 minutes per week, or high-intensity activity for 75 minutes per week, or the equivalent amount of combined moderate- and high-intensity exercise. In order to gain additional health benefits, an individual should engage in at least 300 minutes of moderate-intensity activity, or 150 minutes of high-intensity activity per week, or their combined equivalent. The recommended minimal time of physical activity is 10 minutes[12]. Should an adult be unable to undertake such an activity with the health reasons in mind, WHO recommends undertaking physical activity at any viable level whatsoever[12,13].

The present study aimed to present the physical activity of the participants, their level of compliance with WHO recommendations on physical activity in leisure time, and the actual impact of select socio-economic factors on that level within the study population.

Methods

Participants

Relevant data of 4,619 study participants were subjected to verification. The project aimed to collect comprehensively structured data on essential health and wellbeing factors, as well as gain some insights into the causes of morbidity and mortality within the population under study.

Design

The study protocol comprised the following components: Health Status Questionnaire, medical examinations, anthropometric measurements (body weight, height, waist circumference, hip circumference), collection of biological material (urine and blood samples). The Health Status questionnaire covered the following sections: health status (general health status, disease history), demographic and social factors (gender, age, education, marital status, professional work, type of occupation, total monthly net income of all household members), mental health, lifestyle (smoking, alcohol consumption, diet, physical activity). Information on sex, education, marital status, professional work, total monthly net income of all household members was collected through a direct interview.

Based on the evaluation of the completeness and coherence of data (both horizontal and vertical) pertaining to select socio-economic factors, i.e. sex, age, education, marital status, employment, job type, net monthly income per household, and the self-admitted level of physical activity, as assessed by the long IPAQ questionnaire form, the data for 181 participants were excluded from further assessment. The data collected for 58 participants were found deficient to a considerable extent. The age of two participants failed to meet the inclusion criteria. The data collected for the remaining 121 participants were removed, in line with the IPAQ methodology (e.g. total duration of physical activity should not exceed 960 minutes per day). Detailed analyses were carried out for 4,619 residents participating in the study protocol (1,532 men and 3,087 women, aged 45-65; mean age of 56.41±5.31 years).The study group characteristics are presented in Table 1.

The International Physical Activity Questionnaire (IPAQ – long form) was the research tool of choice. Physical activity was evaluated in four areas of everyday life,

i.e. at a place of work, while commuting daily, while doing regular household chores, and during leisure time. As per the IPAQ methodology, all study subjects were divided according to their total physical activity levels, i.e. low, moderate, and high[14–16].

- Low-level activity (individuals who do not meet the criteria for the other two categories, physical activity at a level below 600 MET-min/week).
- Moderate-level activity (physical activity at a level of 600-1,500 MET-min/week,or1,500-3,000 MET-min/week, although withone or two days comprising high-intensity exercise).
- High-level activity (1,500 MET-min/week, although with at least threedayscomprising high-intensity exercise, over 3,000 MET-min/week).

Outcomes

The primary and secondary outcomes of interest were the self-reported level of compliance with WHO recommendations on physical activity, and moderate- and high-level physical activity during leisure time, respectively.

Confounders and mediators

We made use of the six self-reported potential confounders or mediator variables (sex, age, level of education, marital status, occupational activity, and net income per household). All variables were quantitative; their values fully grounded in the survey questionnaire employed in the study protocol.

Missing data

Net income per household variable contained 36.91% (n = 1,705) of missing data. This might well be attributed to the participants' reluctance to have their income disclosed (e.g. participants with low income could intentionally skip their low income, as they regarded this as a violation of their privacy). The probable MNAR (missing

not a random) type of missing data was assumed. The missing data were construed as yet another value for the categorical variable “net income per household”, and labelled "not specified". In the following parts of the study, multilevel logistic regression models were developed, while making use of both the full data, Inclusive of this brand-new category of missing data, and without them.

Analysis

Multilevel logistic regression was applied. Six multilevel regression models were developed. Model 1 and 1a, Model 2 and 2a, Model 3 and 3a presented socio-economic factors associated with moderate-, high-level physical activity, and WHO recommendations on physical activity during leisure, respectively. Models with “a” inserted into the name (e.g. Model 1a) were based on a portion of the data after the deletion of all cases (n = 1,705) of missing data on the net income per household variable. Effects sizes were presented as odds ratios (OR) with 95% confidence intervals (95% CI). Confidence intervals were based on the profiled log-likelihood function. Akaike Information Criterion (AIC) was a measure of model adjustment. The best one of all the models tested was the one with the smallest AIC. All statistical analyses were completed using the R version 3.4.2.

Results

Table 1 shows the characteristics of the study group. In total, 4,619subjects were assessed (66.83% women),with Body Mass Index valuesranging16.51-52.28 kg/m^2 (mean 27.79±4.41 kg/m^2). It was established that 6.19% of the subjects engaged in low-level physical activity, 48.86% - in moderate-level activity, while high-level activity was observed in 44.94% of them. Compliance with WHO recommendations on physical activity during leisure was observed in 4.21% of the individuals.

Table 1. Study group characteristics in consideration of PA levels, and compliance with WHO recommendations

Variable	n=4619	Moderate-level PA	High-level PA	WHO recommendations
	%	n (%)	n (%)	n (%)
Sex				
Female	66.83	1,596 (51.70)	1,350 (43.73)	104 (3.37)
Male	33.17	661 (43.15)	726 (47.39)	90 (5.87)
Age group				
45-55 years	41.33	859 (45.00)	940 (49.24)	121 (6.34)
56-65 years	58.67	1,398 (51.59)	1,136 (41.92)	73 (2.69)
Education				
Lower level (primary or vocational)	14.48	295 (44.10)	325 (48.58)	12 (1.79)
Upper level (secondary or higher)	85.52	1,962 (49.67)	1,751 (44.33)	182 (4.61)
Marital status				
Single	24.12	541 (48.56)	509 (45.69)	53 (4.76)
In a relationship	75.88	1,716 (48.96)	1,567 (44.71)	141 (4.02)
Professional activity				
Professional active	54.71	1,079 (42.70)	1,284 (50.81)	146 (5.78)
Professional inactive	45.29	1,178 (56.31)	792 (37.86)	48 (2.29)
Net income per household				
<€450	11.82	275 (50.37)	235 (43.03)	12 (2.20)
From €450 to €679	16.56	381 (49.80)	345 (45.10)	16 (2.09)
From €680 to 1,139	20.09	463 (49.89)	408 (43.97)	40 (4.31)
Over €1,140	14.61	345 (51.11)	281 (41.63)	61 (9.04)
Not specified	36.91	793 (46.51)	807 (47.33)	65 (3.81)

Abbreviations: PA: physical activity; n: absolute number

Pursuant to the results yielded by an unadjusted analysis (Table 2), it was established hat female gender, group aged56-65 years, and the upper-level education were the categories associated with the increased odds of moderate-level physical activity. Professionally active status was associated with the decreased

odds of moderate-level physical activity. The opposite pattern of socio-economic categories was observed within the high-level physical activity. Male gender, group aged 45-55 years, upper-level education, professionally active status, and a net income per household ranging€680 - €1.139, and over, were associated with the increased odds of compliance with WHO recommendations on physical activity during leisure.

Table 2. Unadjusted analysis of factors associated with PA levels, and compliance with WHO recommendations

Variable	Moderate-level PA	High-level PA	WHO recommendations
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (male/female)	1.41 (1.25-1.60)	0.86 (0.76-0.98)	0.56 (0.42-0.75)
Age group (45-55 y./56-65 y.)	1.30 (1.16-1.47)	0.74 (0.66-0.84)	0.41 (0.30-0.55)
Education (lower level/upper level)	1.25 (1.06-1.48)	0.84 (0.72-0.99)	2.64 (1.53-5.04)
Marital status (single/in a relationship)	1.02 (0.89-1.16)	0.96 (0.84-1.10)	0.84 (0.61-1.17)
Professional activity (inactive/active)	0.58 (0.51-0.65)	1.70 (1.51-1.91)	2.61 (1.89-3.67)
Net income per household			
from €450 to €679 vs. <€450	0.98 (0.78-1.22)	1.09 (0.87-1.36)	0.95 (0.45-2.07)
from €680 to €1.139 vs.<€450	0.98 (0.79-1.21)	1.04 (0.84-1.29)	2.00 (1.07-4.02)
over €1.140 vs. <€450	1.03 (0.82-1.29)	0.94 (0.75-1.19)	4.42 (2.44-8.70)
not specified vs. <€450	0.86 (0.71-1.04)	1.19 (0.98-1.45)	1.76 (0.98-3.45)

Abbreviations: PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval

Table 3 shows ORs and 95% CI of the socio-economic factors for the six multilevel logistic regression models. Three are based on the full data (n=4,619),and another three are based on the partial data (n=2,914), as explained in the Methods section. Following the adjustment for individual variables, it was investigated how various socio-economic factors affected the likelihood that specific levels of physical activity under study would be encountered more frequently than others. Based on the Models 1 and 2, the relevant categories of variables, i.e. education, professional

activity, and a net income per household, were juxtaposed against the likelihood of moderate- and high-level physical activity. Models 3 and 3a were similar and fitted, based on the same predictors. Female gender, age 56-65 years, living in a relationship, were associated with the decreased odds, whereas upper-level education, and a net income per household ranging€680 - €1.139, and over, were associated with the increased odds of compliance with WHO recommendations on physical activity during leisure. For all the fitting models, the reduced AIC was noted, following the inclusion of individual variables.

Table 3. Multilevel regression models of factors associated with PA levels, and compliance with WHO recommendations

Variable	Model 1	Model 1a	Model 2	Model 2a	Model 3	Model 3a
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (male/female)	1.32 (1.16-1.50)	1.43 (1.21-1.68)			0.58 (0.43-0.79)	0.50 (0.34-0.73)
Age group (45-55 y./56-65 y.)					0.46 (0.34-0.61)	0.42 (0.29-0.62)
Education (lower-level/upper level)	1.29 (1.09-1.54)		0.78 (0.66-0.93)		2.22 (1.27-4.28)	2.35 (1.09-6.13)
Marital status (single/in a relationship)			1.86 (1.64-2.11)		0.54 (0.38-0.77)	0.51 (0.32-0.81)
Professional activity (inactive/active)	0.54 (0.48-0.62)			1.86 (1.58-2.19)		
Net income per household						
from €450 to €679 vs. <€450						
from €680 to €1.139 vs.<€450	1.25 (1.00-1.56)	1.31 (1.05-1.64)			2.03 (1.05-4.21)	2.00 (1.01-4.23)
over €1.140 vs. <€450	1.54 (1.21-1.97)	1.68 (1.31-2.17)	0.69 (0.54-0.88)	0.66 (0.51-0.84)	3.73 (1.95-7.67)	3.56 (1.80-7.56)
not specified vs. <€450		not applicable		not applicable		not applicable
Null model AIC	6402.9	4041.6	6358.0	3993.0	1611.7	1058.5
Final model AIC	6284.0	3969.3	6263.1	3942.6	1526.3	983.0

Abbreviations: PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval; AIC: Akaike Information Criterion; Model 1 and 1a: moderate-level PA; Model 2 and 2a: high-level PA; Model 3 and 3a: WHO recommendations on physical activity during leisure

Discussion

Lack of physical activity at every stage of human life is certain to bring adverse effects[17]. Understanding why people remain either physically active or inactive might therefore prove helpful in tailoring certain structured prevention measures to the well-defined population needs, and consequently target specific civilizational diseases more effectively[18–20].

Diverse and complex impact of socio-demographic factors on the level of physical activity pursued by the study subjects were evaluated. High net income per household member increased the likelihood of moderate physical activity being undertaken, while reducing that of a high level one. Net income also modified the likelihood of compliance with pertinent WHO recommendations. This impact was also clearly detectable with respect to the model taking into account the missing data as a variable within a separate category of net income per household member, as well as when disregarding it. In our study, the implementation of WHO recommendations for physical activity in leisure time proved to be by far the most complex in terms of the actual impact of the socio-demographic factors under study. In the regression models, only the type of occupational activity had no impact on its occurrence. This only highlights a great diversity of conditions that may modify basic manifestations of human endeavours within a lifetime; spontaneous physical activity in leisure time among them.

In other studies, a high level of physical activity was reported for the subjects living in New Zealand, the Czech Republic, United States, and Australia. On the other hand, the subjects in the countries such as Belgium, Japan, Brazil, and Taiwan, were the least likely to undertake high-level physical activity[21]. The situation in Finland is altogether different. Throughout over 30 years of research, a systematic increase in

physical activity in leisure time was noted[22]. This increase may well be attributable to systematically pursued promotion of physical activity throughout the country. Nevertheless, around one third of adult population across the world fails to pursue individually any health-promoting physical activity.

In order to monitor public health status effectively, it is essential to determine the number of individuals who undertake physical activity, and to recognize and understand which specific modifiable factors and motives influence an individual willingness to do so[23,24].The most important finding of the present study consists in establishing the discrepancy between the level of self-admitted physical activity of the subjects, and the actual level of implementation of WHO recommendations. Even though well over 80% of the subjects was allocated into the moderate and high-level categories, specific WHO recommendations were met by 4.2% of them only.

The results of research on physical activity pursued within a population, as conducted in Europe, revealed that the majority of respondents failed to comply with WHO recommendations on physical activity[13,14,25–32].

Around one quarter of the European population does not follow WHO recommendations on physical activity, which might be attributable to certain inequalities between respective countries, as well as to the ones encountered within them[33].

Considering the differences in the level of physical activity pursued across the Western and Central and Eastern European countries, it seems prudent enough to have the programmes aimed at promoting individual physical activity designed and structured on a local level. This approach would then stand a far better chance of actually reaching out to the least physically active population groups. Taking into account the differences in compliance with WHO specific recommendations on

physical activity, it would also be advisable to consider whether these guidelines should actually be addressed to all social strata within the same scope. Current WHO recommendations take into account the age factor only. In the light of the latest research, it would seem rather prudent to assume that a number of other socio-economic factors acknowledged to impact individual level of physical activity, e.g. gender, education, type of occupation, economic status, region of residence, be also granted due consideration.

Disregarding those other factors by WHO may well inadvertently become instrumental in the non-compliance with its recommendations on physical activity in respective European countries, especially across Central and Eastern Europe. About 40% of 53 European countries have never developed their own guidelines on physical activity in which the specific WHO recommendations would be reflected to some extent. This group comprises Poland and the countries of Central and Eastern Europe[34].

Following the systemic transformation in the early 1990s, those countries strive to match overall quality of life in Western Europe. In result of embracing wholesale consumerism, physical activity as a lifestyle factor has been pushed to a much more inferior position in the order of life's priorities. Besides, state-of-the-art technological advances and brand-new social trends emerging in the developing countries make sedentary lifestyle steadily more and more common across Central and Eastern Europe. WHO indicates that hypokinesia and sedentary lifestyle are deemed legitimate risk factors for civilizational diseases[35]

With a view to appreciably increasing the chances for compliance with WHO recommendations on physical activity, overall public awareness of an appreciably advantageous effect of physical activity on individual health status should definitely

be raised. Owing to social, cultural and economic differences encountered between Western and Eastern Europe, specific recommendations on physical activity should be developed on a local level.

It is rather hard to determine whether the WHO recommendations are obsolete, or whether the countries of Central and Eastern Europe have not as yet reached that particular stage of development whereupon their implementation has become a standard lifestyle requirement. In order to take up this challenge, it is vital to establish the actual level of physical activity and the nature of the relationship between physical activity and specific socio-economic factors within a particular locality, and consequently have the recommendations on physical activity effectively adapted to the specific needs of a local population.

Further research is obviously required, with a view to identifying potential environmental factors specific to a particular region/locality, which could account for the differences in population behavioural models, especially in relation to physical activity across Europe at large.

Study limitations

One of the more obvious drawbacks was that the study protocol did not provide for a verification of an individual physical activity through objective assessment methods (e.g. accelerometer, pedometer). As the study design did not envisage any follow-up, either, there was no opportunity to establish whether the very fact of addressing the survey questionnaire by the respondents may have in any way affected their individual lifestyles, e.g. encourage them to take up any type of regular physical activity.

In conclusion

The results yielded by the present study indicate that despite undertaking a moderate level of physical activity, a mid-sized, Central-European city, its residents-study subjects failed to comply with WHO recommendations on physical activity in leisure time. The level of physical activity and compliance with WHO recommendations were determined by socio-economic factors, e.g. sex, age, education, marital status, and the net monthly income per household. The effect of each of these factors, however, was by no means discrete; they either complemented or eliminated one another. Individual factors may affect physical activity either positively or adversely. Boosting overall level of individual physical activity, especially during leisure time, should therefore be recognized as a legitimate, as well as a fundamental objective of any consistently pursued public health policy. Global epidemic of chronic, non-infectious diseases (cardiovascular diseases, obesity, type 2 diabetes, cancer)is commonly believe do be directly tied to the on-going changes in lifestyle, including appreciably reduced physical activity, especially during leisure time. Since a low level of physical activity is deemed a most prevalent risk factor for civilisational diseases, its systemic monitoring appears vitally important in terms of prioritizing, especially when mapping out public health policy guidelines.

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Footnotes

Contributors

PM – conceptualization, formal analysis, investigation, methodology, project administration, resources, supervision, writing - review & editing

MTD – data curation, formal analysis, project administration, resources, software, validation, writing - original draft

MZ – conceptualization, formal analysis, investigation, methodology, validation, writing - original draft, writing - review & editing.

MB – software, funding acquisition, supervision, resources

PC – funding acquisition, software, supervision, visualization

HK – data curation, project administration, resources

JSK – data curation, project administration, resources

SG – formal analysis, funding acquisition, investigation, supervision, validation, visualization, writing - original draft.

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Availability of data and material:

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

Data sharing statement: Interview guide and codebook available by request to the Corresponding Author.

Exclusive Licence:

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*)*Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	8

		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21-22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

WHO recommendations on physical activity vs. compliance rate within a mid-sized, Central-European city

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WHO recommendations on physical activity vs. compliance rate within a specific urban population, as assessed through IPAQ survey

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WHO recommendations on physical activity vs. compliance rate within a specific urban population, as assessed through IPAQ survey

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ABSTRACT

Objective: The study was designed to address the following three key areas, i.e. (1) evaluate overall level of physical activity in the residents of a mid-sized, Central-European city, (2) compliance level with World Health Organization's (WHO) recommendations on physical activity in leisure time, (3) actual impact of select socio-economic factors on the physical activity level within the study population.

Methods: Assessment of the source data collected for 4,619 participants (1,532 men and 3,087 women, aged 45-65; mean age 56.41±5.31 years) was completed. Three levels of physical activity, and compliance level with pertinent WHO recommendations was evaluated, based on *IPAQ (long form)*. Multilevel logistic regression models of socio-economic factors associated with moderate-, high-level physical activity, and WHO recommendations were developed.

Results: Data analyses revealed that 6.19% of the study participants (n=286) engaged in low-level physical activity, 48.86% - in moderate-level activity, while high-level activity was reported in 44.94% of them. Compliance with pertinent WHO recommendations was higher in men aged 44-55, boasting upper-level education, living without a partner, and in the persons with a net income over €1,140 per household.

Conclusions: Overall level of physical activity in the residents of a mid-sized, Central-European city was established as moderate. Pertinent WHO recommendations on physical activity were met by 4.2% of the subjects only.

Key words: physical activity, leisure time, WHO recommendations, public health, physically active lifestyle

Trial registration: Not required, as the study design envisaged no health interventions whatsoever.

Strengths and limitations of this study

- The level of self-admitted, individually pursued physical activity found dependent on select socio-economic factors.
- WHO recommendations on physical activity found in urgent need of upgrading to account for on-going changes in populations' lifestyles.
- No objective assessment methods (e.g. accelerometer, pedometer) employed in the study protocol.

Introduction

Lack of physical activity in conjunction with sedentary lifestyle are deemed by far the most hazardous to any modern-day population,[1–6]. If physical activity is to offer any beneficial effects whatsoever, certain key criteria must be complied with, e.g. frequency and intensity. Physical activity should be approached comprehensively in terms of actual exertion in different areas of everyday life, i.e. at work, at home, while travelling or commuting, and in leisure time,[1]. Assessment of physical activity level helps making viable predictions on individual health status. It also plays an essential role in promoting one's physical and mental wellbeing, as well as public health at large,[2].

On-going evolution of individual lifestyles is invariably affected by changes occurring within human environment. Overall deficiency in physical activity, associated with a diversity of modern conveniences commonly available in everyday life holds serious implications for human health status. Lack of regular physical activity contributes to the development of chronic diseases, e.g. cardiovascular diseases, metabolic

disorders, cancer, respiratory diseases, musculoskeletal disorders, neurological diseases,[4,7,8].

Physical activity is vital for retaining good health,[9–12], shaping a health-promoting lifestyle, as well as offers an attractive option for spending leisure time. Lack of physical activity in a population may prove instrumental in placing an appreciable burden on both national economy, and public healthcare system, primarily by way of appreciably increasing expenditure on the healthcare services for the individuals unfit to work. Much wider appreciation of an essential role physical activity plays in prevention and treatment of assorted life-style diseases has generated increased interest in the physically active dimension of life.

Even though beneficial effects of physical activity are widely acknowledged, more than 30% of adults in Europe seldom get involved in any physical exercise regimens, [13]. According to WHO, any physical activity is better than none at all, with the benefits largely independent of sex, race, or ethnicity,[14,15]. WHO recommends that healthy adults aged 18-64 years should engage in moderate-intensity physical activity for at least 150 minutes per week, or high-intensity activity for 75 minutes per week, whereas for extra health benefits, an individual should engage in at least 300 minutes of moderate-intensity activity, or 150 minutes of high-intensity activity per week, or their combined equivalent. The recommended minimal time of physical activity is 10 minutes,[16]. According to long IPAQ questionnaire form, physical activity of a particular study population is assessed in four domains (work, home, transport, free time). The minimum duration of a single physical activity is set at 10 minutes, at the very least. Any such an activity is comprised of physical activities originating in different domains, lasting at least 10 minutes each. Should an adult be

unable to undertake such an activity with the health reasons in mind, WHO recommends undertaking physical activity at any viable level whatsoever,[16,17].

The present study aimed to present the physical activity of the PONS study participants by way of addressing three key areas:

(1) evaluation of overall level of physical activity in the participants of a mid-sized, Central-European city

(2) compliance level with World Health Organization's (WHO) recommendations on physical activity in leisure time

(3) actual impact of select socio-economic factors on the level of physical activity within the study population.

Methods

Participants and procedures

Relevant data of 4,619 study participants were subjected to verification. The project aimed to collect comprehensively structured data on essential health and wellbeing factors, as well as gain some insights into the causes of morbidity and mortality within the population under study. The PONS (Polish - Norwegian Study) Project "Establishment of infrastructure for population health research in Poland", based on collaboration between Polish and Norwegian scientists, aimed to collect extensive data in the population under study on the key factors regarding individual health status and well-being, as well as gain some insights into the actual causes of morbidity and mortality in Poland. The PONS survey was conducted in the city of Kielce (The Świętokrzyskie Region). The study population was comprised of persons aged 45-64 years. This Project was in fact a continuation of the international HEM - Closing the Gap project, pursued in the Oncology Centre, Warsaw.

The study protocol comprised the following components: Health Status Questionnaire, medical examinations, anthropometric measurements (body weight, height, waist circumference, hip circumference), collection of biological material (urine and blood samples). The questionnaire covered the following sections: health status (general health status, disease history), demographic and social factors (gender, age, education, marital status, professional work, type of occupation, total monthly net income of all household members), mental health, lifestyle (smoking, alcohol consumption, diet, physical activity). Information on gender, education, marital status, professional work, total monthly net income of all household members was collected through a direct interview.

Based on the evaluation of the completeness and coherence of data (both horizontal and vertical) pertaining to select socio-economic factors, i.e. gender, age, education, marital status, employment, job type, net monthly income per household, and the self-admitted level of physical activity, as assessed by the long IPAQ questionnaire form, the data for 181 participants were excluded from further assessment. The data collected for 58 participants were found deficient to a considerable extent. The age of two participants failed to meet the inclusion criteria. The data collected for the remaining 121 participants were removed, in line with the IPAQ methodology (e.g. total duration of physical activity should not exceed 960 minutes per day). Detailed analyses were carried out for 4,619 participants that took part in the study protocol (1,532 men and 3,087 women, aged 45-65; mean age of 56.41±5.31 years). The study group characteristics are presented in Table 1.

The International Physical Activity Questionnaire (IPAQ – long form) was the research tool of choice. Physical activity was evaluated in four areas of everyday life, i.e. at a place of work, while commuting daily, while doing regular household chores,

and during leisure time. As per the IPAQ methodology, the participants were divided according to their total physical activity levels, i.e. low, moderate, and high,[18,19].

- Low-level activity (individuals who do not meet the criteria for the other two categories, physical activity at a level below 600 MET-min/week).
- Moderate-level activity (physical activity at a level of 600-1,500 MET-min/week, or 1,500-3,000 MET-min/week, although with one or two days comprising high-intensity exercise).
- High-level activity (1,500 MET-min/week, although with at least three days comprising high-intensity exercise, over 3,000 MET-min/week).

Outcomes

The primary and secondary outcomes of interest were the self-reported level of compliance with WHO recommendations on physical activity, and moderate- and high-level physical activity during leisure time, respectively.

Confounders and mediators

We made use of the six self-reported potential confounders or mediator variables (gender, age, level of education, marital status, occupational activity, and net income per household). All variables were quantitative; their values fully grounded in the survey questionnaire employed in the study protocol.

Missing data

Net income per household variable contained 36.91% (n = 1,705) of missing data. This might well be attributed to the participants' reluctance to have their income disclosed (e.g. participants with low income could intentionally skip their low income, as they regarded this as a violation of their privacy). The probable MNAR (missing not a random) type of missing data was assumed. The missing data were construed as yet another value for the categorical variable “net income per household”, and

labelled "not specified". In the following parts of the study, multilevel logistic regression models were developed, while making use of both the full data, Inclusive of this brand-new category of missing data, and without them.

Analysis

Multilevel logistic regression was applied. Six multilevel regression models were developed. Model 1 and 1a, Model 2 and 2a, Model 3 and 3a presented socio-economic factors associated with moderate-, high-level physical activity, and WHO recommendations on physical activity during leisure, respectively. Models with “a” inserted into the name (e.g. Model 1a) were based on a portion of the data after the deletion of all cases (n = 1,705) of missing data on the net income per household variable. Effects sizes were presented as odds ratios (OR) with 95% confidence intervals (95% CI). Confidence intervals were based on the profiled log-likelihood function. Akaike Information Criterion (AIC) was a measure of model adjustment. The best one of all the models tested was the one with the smallest AIC. All statistical analyses were completed using the R version 3.4.2.

Patient and Public Involvement

The Authors represent that neither any patients, nor any members of the public were in any way involved in designing, nor in conducting the study protocol. In view of the actual specifics of its design, the Authors do not envisage having the study outcomes disseminated to its participants.

Results

Table 1 shows the characteristics of the study group. In total, 4,619 subjects were assessed (66.83% women),with Body Mass Index valuesranging16.51-52.28 kg/m^2 (mean 27.79±4.41 kg/m^2). It was established that 6.19% of the subjects engaged in

low-level physical activity, 48.86% in moderate-level activity, while high-level activity was observed in 44.94% of them. Compliance with WHO recommendations on physical activity during leisure was observed in 4.21% of the individuals.

Table 1. Study group characteristics in consideration of PA levels, and compliance with WHO recommendations

Variable	n=4619	Moderate-level PA	High-level PA	WHO recommendations
	%	n (%)	n (%)	n (%)
Sex				
Female	66.83	1,596 (51.70)	1,350 (43.73)	104 (3.37)
Male	33.17	661 (43.15)	726 (47.39)	90 (5.87)
Age group				
45-55 years	41.33	859 (45.00)	940 (49.24)	121 (6.34)
56-65 years	58.67	1,398 (51.59)	1,136 (41.92)	73 (2.69)
Education				
Lower level (primary or vocational)	14.48	295 (44.10)	325 (48.58)	12 (1.79)
Upper level (secondary or higher)	85.52	1,962 (49.67)	1,751 (44.33)	182 (4.61)
Marital status				
Single	24.12	541 (48.56)	509 (45.69)	53 (4.76)
In a relationship	75.88	1,716 (48.96)	1,567 (44.71)	141 (4.02)
Professional activity				
Professional active	54.71	1,079 (42.70)	1,284 (50.81)	146 (5.78)
Professional inactive	45.29	1,178 (56.31)	792 (37.86)	48 (2.29)
Net income per household				
<€450	11.82	275 (50.37)	235 (43.03)	12 (2.20)
From €450 to €679	16.56	381 (49.80)	345 (45.10)	16 (2.09)
From €680 to 1,139	20.09	463 (49.89)	408 (43.97)	40 (4.31)
Over €1,140	14.61	345 (51.11)	281 (41.63)	61 (9.04)
Not specified	36.91	793 (46.51)	807 (47.33)	65 (3.81)

Abbreviations: PA: physical activity; n: absolute number

Pursuant to the results yielded by an unadjusted analysis (Table 2), it was observed that female gender, group aged 56-65 years, and the upper-level education were the categories associated with the increased odds of moderate-level physical activity. Professionally active status was associated with the decreased odds of moderate-level physical activity. The opposite pattern of socio-economic categories was observed within the high-level physical activity. Male gender, group aged 45-55 years, upper-level education, professionally active status, and a net income per household ranging €680 - €1.139, and over, were associated with the increased odds of compliance with WHO recommendations on physical activity during leisure.

Table 2. Unadjusted analysis of factors associated with PA levels, and compliance with WHO recommendations

Variable	Moderate-level PA	High-level PA	WHO recommendations
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (male/female)	1.41 (1.25-1.60)	0.86 (0.76-0.98)	0.56 (0.42-0.75)
Age group (45-55 y./56-65 y.)	1.30 (1.16-1.47)	0.74 (0.66-0.84)	0.41 (0.30-0.55)
Education (lower level/upper level)	1.25 (1.06-1.48)	0.84 (0.72-0.99)	2.64 (1.53-5.04)
Marital status (single/in a relationship)	1.02 (0.89-1.16)	0.96 (0.84-1.10)	0.84 (0.61-1.17)
Professional activity (inactive/active)	0.58 (0.51-0.65)	1.70 (1.51-1.91)	2.61 (1.89-3.67)
Net income per household			
from €450 to €679 vs. <€450	0.98 (0.78-1.22)	1.09 (0.87-1.36)	0.95 (0.45-2.07)
from €680 to €1.139 vs.<€450	0.98 (0.79-1.21)	1.04 (0.84-1.29)	2.00 (1.07-4.02)
over €1.140 vs. <€450	1.03 (0.82-1.29)	0.94 (0.75-1.19)	4.42 (2.44-8.70)
not specified vs. <€450	0.86 (0.71-1.04)	1.19 (0.98-1.45)	1.76 (0.98-3.45)

Abbreviations: PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval

Table 3 shows ORs and 95% CI of the socio-economic factors for the six multilevel logistic regression models. Three are based on the full data (n=4,619),and another

three are based on the partial data (n=2,914), as explained in the Methods section. Following the adjustment for individual variables, it was investigated how various socio-economic factors affected the likelihood that specific levels of physical activity under study would be encountered more frequently than others. Based on the Models 1 and 2, the relevant categories of variables, i.e. education, professional activity, and a net income per household, were juxtaposed against the likelihood of moderate- and high-level physical activity. Models 3 and 3a were similar and fitted, based on the same predictors. Female gender, age 56-65 years, living in a relationship, were associated with the decreased odds, whereas upper-level education, and a net income per household ranging €680 - €1.139, and over, were associated with the increased odds of compliance with WHO recommendations on physical activity during leisure. For all the fitting models, the reduced AIC was noted, following the inclusion of individual variables.

Table 3. Multilevel regression models of factors associated with PA levels, and compliance with WHO recommendations

Variable	Model 1	Model 1a	Model 2	Model 2a	Model 3	Model 3a
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (male/female)	1.32 (1.16-1.50)	1.43 (1.21-1.68)			0.58 (0.43-0.79)	0.50 (0.34-0.73)
Age group (45-55 y./56-65 y.)					0.46 (0.34-0.61)	0.42 (0.29-0.62)
Education (lower-level/upper level)	1.29 (1.09-1.54)		0.78 (0.66-0.93)		2.22 (1.27-4.28)	2.35 (1.09-6.13)
Marital status (single/in a relationship)			1.86 (1.64-2.11)		0.54 (0.38-0.77)	0.51 (0.32-0.81)
Professional activity (inactive/active)	0.54 (0.48-0.62)			1.86 (1.58-2.19)		
Net income per household						
from €450 to €679 vs. <€450						
from €680 to €1.139 vs.<€450	1.25 (1.00-1.56)	1.31 (1.05-1.64)			2.03 (1.05-4.21)	2.00 (1.01-4.23)
over €1.140 vs. <€450	1.54 (1.21-1.97)	1.68 (1.31-2.17)	0.69 (0.54-0.88)	0.66 (0.51-0.84)	3.73 (1.95-7.67)	3.56 (1.80-7.56)
not specified vs. <€450		not applicable		not applicable		not applicable
Null model AIC	6402.9	4041.6	6358.0	3993.0	1611.7	1058.5
Final model AIC	6284.0	3969.3	6263.1	3942.6	1526.3	983.0

Abbreviations: PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval; AIC: Akaike Information Criterion; Model 1 and 1a: moderate-level PA; Model 2 and 2a: high-level PA; Model 3 and 3a: WHO recommendations on physical activity during leisure

Discussion

Diverse and complex impact of socio-demographic factors on the level of physical activity pursued by the participants was assessed. High net income per household member increased the likelihood of moderate physical activity being undertaken, while reducing that of a high level one. Net income also modified the likelihood of compliance with pertinent WHO recommendations. This impact was also clearly detectable with respect to the model taking into account the missing data as a variable within a separate category of net income per household member, as well as when disregarding it. In the present study, the implementation of WHO recommendations for physical activity in leisure time proved to be by far the most complex in terms of the actual impact of the socio-demographic factors under study. In the regression models, only the type of occupational activity had no impact on its occurrence. This only goes to highlight a great diversity of conditions that may modify basic manifestations of human endeavours within a lifetime; spontaneous physical activity in leisure time among them.

In other studies, a high level of physical activity was reported for the subjects living in New Zealand, the Czech Republic, United States, and Australia. On the other hand, the subjects in the countries such as Belgium, Japan, Brazil, and Taiwan, were the least likely to undertake high-level physical activity,[20]. The situation in Finland is altogether different. Throughout over 30 years of research, a systematic increase in physical activity in leisure time was noted,[21]. This increase may well be attributable to systematically pursued promotion of physical activity throughout the country. Nevertheless, around one third of adult population across the world fails to pursue individually any health-promoting physical activity,[22].

In order to monitor public health status effectively, it is essential to determine the number of individuals who undertake physical activity, and to recognize and understand which specific modifiable factors and motives influence an individual willingness to do so,[23,24]. The most important finding of the present study consists in establishing the discrepancy between the level of self-admitted physical activity of the subjects, and the actual level of implementation of pertinent WHO recommendations. Even though well over 80% of the subjects was allocated into the moderate and high-level categories, specific WHO recommendations were met by 4.2% of them only.

The results of research on physical activity pursued within a population, as conducted in Europe, revealed that a majority of respondents failed to comply with WHO recommendations on physical activity,[18, 25-31].

Around one quarter of the European population does not follow WHO recommendations on physical activity, which might be attributable to certain inequalities between respective countries, as well as to the ones encountered within them,[32]. Along with a diversity of on-going changes in man's immediate environment, significant changes in people's lifestyle are simply inevitable. Civilisational progress accompanied by all-embracing automation and mechanization in all major areas of life have appreciably contributed to overall reduction of people's physical activity. Research into physical activity has highlighted several factors that actually differentiate people's approach to this issue, e.g. age, gender, individual health condition, individual motivation,[33].

Considering the differences in the level of physical activity pursued across the Western and Central and Eastern European countries, it seems prudent enough to have the programmes aimed at promoting individual physical activity designed and

structured on a local level. This approach would then stand a far better chance of actually reaching out to the least physically active population groups. Taking into account the differences in compliance with WHO specific recommendations on physical activity, it would also be advisable to consider whether these guidelines should actually be addressed to all social strata within the same scope. Current WHO recommendations take into account the age factor only. In the light of the latest research, it would seem rather prudent to assume that a number of other socio-economic factors acknowledged to impact individual level of physical activity, e.g. gender, education, type of occupation, economic status, region of residence, be also granted due consideration.

Disregarding those other factors by WHO may well inadvertently become instrumental in the non-compliance with its recommendations on physical activity in respective European countries, especially across Central and Eastern Europe. About 40% of 53 European countries have never developed their own guidelines on physical activity in which the specific WHO recommendations would be reflected to some extent. This group comprises Poland and the countries of Central and Eastern Europe,[34].

Following the systemic transformation in the early 1990s, those countries strive to match overall quality of life in Western Europe. In result of embracing wholesale consumerism, physical activity as a lifestyle factor has been pushed to a much more inferior position in the order of life's priorities. Besides, state-of-the-art technological advances and brand-new social trends emerging in the developing countries make sedentary lifestyle steadily more and more common across Central and Eastern Europe. WHO indicates that hypokinesia and sedentary lifestyle are deemed legitimate risk factors for civilizational diseases,[35].

With a view to appreciably increasing the chances for compliance with WHO recommendations on physical activity, overall public awareness of an appreciably advantageous effect of physical activity on individual health status should definitely be raised. Owing to social, cultural and economic differences encountered between Western and Eastern Europe, specific recommendations on physical activity should be developed on a local level.

It is rather hard to determine whether the WHO recommendations are obsolete, or whether the countries of Central and Eastern Europe have not as yet reached that particular stage of development whereupon their implementation has become a standard lifestyle requirement. In order to take up this challenge, it is vital to establish the actual level of physical activity and the nature of the relationship between physical activity and specific socio-economic factors within a particular locality, and consequently have the recommendations on physical activity effectively adapted to the specific needs of a local population.

Further research is obviously required, with a view to identifying potential environmental factors specific to a particular region/locality, which could account for the differences in population behavioural models, especially in relation to physical activity across Europe at large.

Study limitations

One of the more obvious drawbacks was that the study protocol did not provide for any verification of an individual physical activity through objective assessment methods (e.g. accelerometer, pedometer). As the study design did not envisage any follow-up, either, there was no opportunity to establish whether the very fact of addressing the survey questionnaire by the respondents may have in any way

affected their individual lifestyles, e.g. encourage them to take up any type of regular physical activity.

In conclusion

The results yielded by the present study indicate that despite undertaking a moderate level of physical activity, the residents of a mid-sized, Central-European city, i.e. study participants failed to comply with WHO recommendations on physical activity in leisure time. The level of physical activity and compliance with WHO recommendations were determined by socio-economic factors, e.g. gender, age, education, marital status, and the net monthly income per household. The effect of each of these factors, however, was by no means discrete; they either complemented or eliminated one another. Individual factors may affect overall physical activity level either favourably or adversely.

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Footnotes

Contributors

PM – conceptualization, formal analysis, investigation, methodology, project administration, resources, supervision, writing - review & editing

MTD – data curation, formal analysis, project administration, resources, software, validation, writing - original draft

MZ – conceptualization, formal analysis, investigation, methodology, validation, writing - original draft, writing - review & editing.

MB – software, funding acquisition, supervision, resources

PC – funding acquisition, software, supervision, visualization

HK – data curation, project administration, resources

JSK – data curation, project administration, resources

SG – formal analysis, funding acquisition, investigation, supervision, validation, visualization, writing - original draft.

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Data sharing statement: Interview guide and codebook available by request to the Corresponding Author.

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*)*Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	8

		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21-22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

WHO recommendations on physical activity vs. compliance rate within a mid-sized, Central-European city

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WHO recommendations on physical activity vs. compliance rate within a specific urban population as assessed through IPAQ survey - a cross-sectional cohort study

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WHO recommendations on physical activity vs. compliance rate within a specific urban population as assessed through IPAQ survey - a cross-sectional cohort study

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ABSTRACT

Objective: The study was designed to address the following three key areas, i.e. (1) evaluate overall level of physical activity in the residents of a mid-sized, Central-European city, (2) compliance level with World Health Organization's (WHO) recommendations on physical activity in leisure time, (3) actual impact of select socio-economic factors on the physical activity level within the study population.

Methods: Assessment of the source data collected for 4,619 participants (1,532 men and 3,087 women, aged 45-65; mean age 56.41±5.31 years) was completed. Three levels of physical activity, and compliance level with pertinent WHO recommendations was evaluated, based on IPAQ (long form). Multilevel logistic regression models of socio-economic factors associated with moderate-, high-level physical activity, and WHO recommendations were developed.

Results: Data analyses revealed that 6.19% of the study participants (n=286) engaged in low-level physical activity, 48.86% - in moderate-level activity, while high-level activity was reported in 44.94% of them. Compliance with pertinent WHO recommendations was higher in men aged 44-55, boasting upper-level education, living without a partner, and in the persons with a net income over €1,140 per household.

Conclusions: Overall level of physical activity in the residents of a mid-sized, Central-European city was established as moderate. Pertinent WHO recommendations on physical activity were met by 4.2% of the subjects only.

Key words: physical activity, leisure time, WHO recommendations, public health, physically active lifestyle

Strengths and limitations of this study

- PONS is one of the first cohort research projects in Central and Eastern Europe focused on the lifestyle-related, chronic disease risk factors
- Assessment of health-promoting, social paradigms helps identify prevalent perception of health issues, depending on the respondents' specific positioning within a social structure
- Failure to pursue a health-promoting lifestyle by the study participants was often owed not so much to individual ill will, as to an interplay of several environmental factors characteristic for a specific socio-ecological paradigm
- Even though the recruitment process, based on voluntary participation, never affected the intrinsic value of the study outcomes, due caution is still recommended in their interpretation
- No objective assessment methods (e.g. accelerometer, pedometer) were employed in the study protocol.

Introduction

Lack of physical activity in conjunction with sedentary lifestyle are deemed by far the most hazardous to any modern-day population,[1–6]. If physical activity is to offer any beneficial effects whatsoever, certain key criteria must be complied with, e.g. frequency and intensity. Physical activity should be approached comprehensively in terms of actual exertion in different areas of everyday life, i.e. at work, at home, while travelling or commuting, and in leisure time,[1]. Assessment of physical activity level is instrumental in making viable predictions on individual health status. It also plays an essential role in promoting one's physical and mental wellbeing, as well as public health at large,[2].

On-going evolution of individual lifestyles is invariably affected by ongoing changes within human environment. Overall deficiency in physical activity, especially when associated with a diversity of modern conveniences commonly available in everyday life, holds serious implications for human health status. Lack of regular physical activity contributes to the development of chronic diseases, e.g. cardiovascular diseases, metabolic disorders, cancer, respiratory diseases, musculoskeletal disorders, neurological diseases,[4,7,8].

Physical activity is vital for retaining good health,[9–12], shaping a health-promoting lifestyle, as well as offers an attractive option for spending leisure time. Lack of physical activity in a population may contribute to placing a significant burden on both national economy, and public healthcare system, primarily by way of appreciably increasing expenditure on the healthcare services for the individuals unfit to work. Much wider appreciation of an essential role physical activity plays in prevention and treatment of assorted life-style diseases has generated increased interest in the physically active dimension of life.

Even though beneficial effects of physical activity are widely acknowledged, more than 30% of adults in Europe seldom get involved in any physical exercise regimens, [13]. According to WHO, any physical activity is better than none at all, with the benefits largely independent of sex, race, or ethnicity,[14,15]. WHO recommends that healthy adults aged 18-64 years should engage in moderate-intensity physical activity for at least 150 minutes per week, or high-intensity activity for 75 minutes per week, whereas for extra health benefits, an individual should engage in at least 300 minutes of moderate-intensity activity, or 150 minutes of high-intensity activity per week, or their combined equivalent. The recommended minimal time of physical activity is 10 minutes,[16]. According to long IPAQ questionnaire form, physical activity of a particular study population is assessed in four domains (work, home, transport, free time). The minimum duration of a single physical activity is set at 10 minutes, at the very least. Any such an activity is comprised of physical activities originating in different domains, lasting at least 10 minutes each. Should an adult be unable to undertake such an activity with the health reasons in mind, WHO recommends undertaking physical activity at any viable level whatsoever,[16,17].

The present study aimed to present the physical activity of the PONS study participants by way of addressing three key areas:

(1) evaluation of overall level of physical activity in the participants of a mid-sized, Central-European city

(2) compliance level with World Health Organization's (WHO) recommendations on physical activity in leisure time

(3) actual impact of select socio-economic factors on the level of physical activity within the study population.

Methods

Participants and procedures

Relevant data of 4,619 study participants were subjected to verification. The project aimed to collect comprehensively structured data on essential health and wellbeing factors, as well as gain some insights into the causes of morbidity and mortality within the population under study. The PONS (Polish - Norwegian Study) Project "Establishment of infrastructure for population health research in Poland", based on collaboration between Polish and Norwegian scientists, aimed to collect extensive data in the population under study on the key factors regarding individual health status and well-being, as well as gain some insights into the actual causes of morbidity and mortality in Poland. The PONS survey was conducted in the city of Kielce (The Świętokrzyskie Region). The study population was comprised of persons aged 45-64 years. This Project was in fact a continuation of the international HEM - Closing the Gap project, pursued in the Oncology Centre, Warsaw.

The study protocol comprised the following components: Health Status Questionnaire, medical examinations, anthropometric measurements (body weight, height, waist circumference, hip circumference), collection of biological material (urine and blood samples). The questionnaire covered the following sections: health status (general health status, disease history), demographic and social factors (gender, age, education, marital status, professional work, type of occupation, total monthly net income of all household members), mental health, lifestyle (smoking, alcohol consumption, diet, physical activity). Information on gender, education, marital status, professional work, total monthly net income of all household members was collected through a direct interview.

Based on the evaluation of the completeness and coherence of data (both horizontal and vertical) pertaining to select socio-economic factors, i.e. gender, age, education, marital status, employment, job type, net monthly income per household, and the self-admitted level of physical activity, as assessed by the long IPAQ questionnaire form, the data for 181 participants were excluded from further assessment. The data collected for 58 participants were found deficient to a considerable extent. The age of two participants failed to meet the inclusion criteria. The data collected for the remaining 121 participants were removed, in line with the IPAQ methodology (e.g. total duration of physical activity should not exceed 960 minutes per day). Detailed analyses were carried out for 4,619 participants that took part in the study protocol (1,532 men and 3,087 women, aged 45-65; mean age of 56.41±5.31 years). The study group characteristics are presented in Table 1.

The International Physical Activity Questionnaire (IPAQ – long form) was the research tool of choice. Physical activity was evaluated in four areas of everyday life, i.e. at a place of work, while commuting daily, while doing regular household chores, and during leisure time. As per the IPAQ methodology, the participants were divided according to their total physical activity levels, i.e. low, moderate, and high,[18,19].

- Low-level activity (individuals who do not meet the criteria for the other two categories, physical activity at a level below 600 MET-min/week).
- Moderate-level activity (physical activity at a level of 600-1,500 MET-min/week, or 1,500-3,000 MET-min/week, although with one or two days comprising high-intensity exercise).
- High-level activity (1,500 MET-min/week, although with at least three days comprising high-intensity exercise, over 3,000 MET-min/week).

Outcomes

The primary and secondary outcomes of interest were the self-reported level of compliance with WHO recommendations on physical activity, and moderate- and high-level physical activity during leisure time, respectively.

Confounders and mediators

We made use of six self-reported potential confounders or mediator variables (i.e. gender, age, level of education, marital status, occupational activity, and net income per household). All variables were quantitative; their values fully grounded in the survey questionnaire applied in the study protocol.

Missing data

Net income per household variable contained 36.91% (n = 1,705) of missing data. This might well be attributed to the participants' reluctance to have their income disclosed (e.g. participants with low income could intentionally skip their low income, as they regarded this as a violation of their privacy). The probable MNAR (missing not a random) type of missing data was assumed. The missing data were construed as yet another value for the categorical variable “net income per household”, and labelled "not specified". In the following parts of the study, multilevel logistic regression models were developed, while making use of both the full data, Inclusive of this brand-new category of missing data, and without them.

Analysis

Multilevel logistic regression was applied. Six multilevel regression models were developed. Model 1 and 1a, Model 2 and 2a, Model 3 and 3a presented socio-economic factors associated with moderate-, high-level physical activity, and WHO

recommendations on physical activity during leisure, respectively. Models with "a" inserted into the name (e.g. Model 1a) were based on a portion of the data after the deletion of all cases (n = 1,705) of missing data on the net income per household variable. Effects sizes were presented as odds ratios (OR) with 95% confidence intervals (95% CI). Confidence intervals were based on the profiled log-likelihood function. Akaike Information Criterion (AIC) was a measure of model adjustment. The best one of all the models tested was the one with the smallest AIC. All statistical analyses were completed using the R version 3.4.2.

Patient and Public Involvement

The authors represent that neither any patients, nor any members of the public were in any way involved in designing, nor in conducting the study protocol. In view of the actual specifics of its design, the authors do not envisage having the study outcomes disseminated to its participants.

Results

Table 1 shows the characteristics of the study group. In total, 4,619 subjects were assessed (66.83% women),with Body Mass Index valuesranging16.51-52.28 kg/m^2 (mean 27.79±4.41 kg/m^2). It was established that 6.19% of the subjects engaged in low-level physical activity, 48.86% in moderate-level activity, while high-level activity was observed in 44.94% of them. Compliance with WHO recommendations on physical activity during leisure was observed in 4.21% of the individuals.

Table 1. Study group characteristics in consideration of PA levels, and compliance with WHO recommendations

Variable	n=4619	Moderate-level PA	High-level PA	WHO recommendations
	%	n (%)	n (%)	n (%)
Sex				
Female	66.83	1,596 (51.70)	1,350 (43.73)	104 (3.37)
Male	33.17	661 (43.15)	726 (47.39)	90 (5.87)
Age group				
45-55 years	41.33	859 (45.00)	940 (49.24)	121 (6.34)
56-65 years	58.67	1,398 (51.59)	1,136 (41.92)	73 (2.69)
Education				
Lower level (primary or vocational)	14.48	295 (44.10)	325 (48.58)	12 (1.79)
Upper level (secondary or higher)	85.52	1,962 (49.67)	1,751 (44.33)	182 (4.61)
Marital status				
Single	24.12	541 (48.56)	509 (45.69)	53 (4.76)
In a relationship	75.88	1,716 (48.96)	1,567 (44.71)	141 (4.02)
Professional activity				
Professional active	54.71	1,079 (42.70)	1,284 (50.81)	146 (5.78)
Professional inactive	45.29	1,178 (56.31)	792 (37.86)	48 (2.29)
Net income per household				
<€450	11.82	275 (50.37)	235 (43.03)	12 (2.20)
From €450 to €679	16.56	381 (49.80)	345 (45.10)	16 (2.09)
From €680 to 1,139	20.09	463 (49.89)	408 (43.97)	40 (4.31)
Over €1,140	14.61	345 (51.11)	281 (41.63)	61 (9.04)
Not specified	36.91	793 (46.51)	807 (47.33)	65 (3.81)

Abbreviations: PA: physical activity; n: absolute number

Pursuant to the results yielded by an unadjusted analysis (Table 2), it was observed that female gender, group aged 56-65 years, and the upper-level education were the categories associated with the increased odds of moderate-level physical activity. Professionally active status was associated with the decreased odds of moderate-

level physical activity. The opposite pattern of socio-economic categories was observed within the high-level physical activity. Male gender, group aged 45-55 years, upper-level education, professionally active status, and a net income per household ranging €680 - €1.139, and over, were associated with the increased odds of compliance with WHO recommendations on physical activity during leisure.

Table 2. Unadjusted analysis of factors associated with PA levels, and compliance with WHO recommendations

Variable	Moderate-level PA	High-level PA	WHO recommendations
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (male/female)	1.41 (1.25-1.60)	0.86 (0.76-0.98)	0.56 (0.42-0.75)
Age group (45-55 y./56-65 y.)	1.30 (1.16-1.47)	0.74 (0.66-0.84)	0.41 (0.30-0.55)
Education (lower level/upper level)	1.25 (1.06-1.48)	0.84 (0.72-0.99)	2.64 (1.53-5.04)
Marital status (single/in a relationship)	1.02 (0.89-1.16)	0.96 (0.84-1.10)	0.84 (0.61-1.17)
Professional activity (inactive/active)	0.58 (0.51-0.65)	1.70 (1.51-1.91)	2.61 (1.89-3.67)
Net income per household			
from €450 to €679 vs. <€450	0.98 (0.78-1.22)	1.09 (0.87-1.36)	0.95 (0.45-2.07)
from €680 to €1.139 vs.<€450	0.98 (0.79-1.21)	1.04 (0.84-1.29)	2.00 (1.07-4.02)
over €1.140 vs. <€450	1.03 (0.82-1.29)	0.94 (0.75-1.19)	4.42 (2.44-8.70)
not specified vs. <€450	0.86 (0.71-1.04)	1.19 (0.98-1.45)	1.76 (0.98-3.45)

Abbreviations: PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval

Table 3 shows ORs and 95% CI of the socio-economic factors for the six multilevel logistic regression models. Three are based on the full data (n=4,619),and another three are based on the partial data (n=2,914), as explained in the Methods section. Following the adjustment for individual variables, it was investigated how various socio-economic factors affected the likelihood that specific levels of physical activity under study would be encountered more frequently than others. Based on the Models 1 and 2, the relevant categories of variables, i.e. education, professional activity, and a net income per household, were juxtaposed against the likelihood of

moderate- and high-level physical activity. Models 3 and 3a were similar and fitted, based on the same predictors. Female gender, age 56-65 years, living in a relationship, were associated with the decreased odds, whereas upper-level education, and a net income per household ranging €680 - €1.139, and over, were associated with the increased odds of compliance with WHO recommendations on physical activity during leisure. For all the fitting models, the reduced AIC was noted, following the inclusion of individual variables.

Table 3. Multilevel regression models of factors associated with PA levels, and compliance with WHO recommendations

Variable	Model 1	Model 1a	Model 2	Model 2a	Model 3	Model 3a
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (male/female)	1.32 (1.16-1.50)	1.43 (1.21-1.68)			0.58 (0.43-0.79)	0.50 (0.34-0.73)
Age group (45-55 y./56-65 y.)					0.46 (0.34-0.61)	0.42 (0.29-0.62)
Education (lower-level/upper level)	1.29 (1.09-1.54)		0.78 (0.66-0.93)		2.22 (1.27-4.28)	2.35 (1.09-6.13)
Marital status (single/in a relationship)			1.86 (1.64-2.11)		0.54 (0.38-0.77)	0.51 (0.32-0.81)
Professional activity (inactive/active)	0.54 (0.48-0.62)			1.86 (1.58-2.19)		
Net income per household						
from €450 to €679 vs. <€450						
from €680 to €1.139 vs.<€450	1.25 (1.00-1.56)	1.31 (1.05-1.64)			2.03 (1.05-4.21)	2.00 (1.01-4.23)
over €1.140 vs. <€450	1.54 (1.21-1.97)	1.68 (1.31-2.17)	0.69 (0.54-0.88)	0.66 (0.51-0.84)	3.73 (1.95-7.67)	3.56 (1.80-7.56)
not specified vs. <€450		not applicable		not applicable		not applicable
Null model AIC	6402.9	4041.6	6358.0	3993.0	1611.7	1058.5
Final model AIC	6284.0	3969.3	6263.1	3942.6	1526.3	983.0

Abbreviations: PA: physical activity; OR: odds ratio; 95% CI: 95% confidence interval; AIC: Akaike Information Criterion; Model 1 and 1a: moderate-level PA; Model 2 and 2a: high-level PA; Model 3 and 3a: WHO recommendations on physical activity during leisure

Discussion

Diverse and complex impact of socio-demographic factors on the level of physical activity pursued by the participants was assessed. High net income per household member increased the likelihood of moderate physical activity being undertaken, while reducing that of a high level one. Net income also modified the likelihood of compliance with pertinent WHO recommendations. This impact was also clearly detectable with respect to the model taking into account the missing data as a variable within a separate category of net income per household member, as well as when disregarding it. In the present study, the implementation of WHO recommendations for physical activity in leisure time proved to be by far the most complex in terms of the actual impact of the socio-demographic factors under study. In the regression models, only the type of occupational activity had no impact on its occurrence. This only goes to highlight a great diversity of conditions that may modify basic manifestations of human endeavours within a lifetime; spontaneous physical activity in leisure time among them.

In other studies, a high level of physical activity was reported for the subjects living in New Zealand, Czech Republic, United States, and Australia. On the other hand, the subjects in the countries such as Belgium, Japan, Brazil, and Taiwan, were the least likely to undertake high-level physical activity,[20]. The situation in Finland is altogether different. Throughout over 30 years of research, a systematic increase in physical activity in leisure time was noted,[21]. This increase may well be attributable to systematically pursued promotion of physical activity throughout the country. Nevertheless, around one third of adult population across the world fails to pursue individually any health-promoting physical activity,[22].

In order to monitor public health status effectively, it is essential to determine the number of individuals who undertake physical activity, and to recognize and understand which specific modifiable factors and motives influence an individual willingness to do so,[23,24]. The most important finding of the present study consists in establishing the discrepancy between the subjects' level of self-admitted physical activity, and the actual implementation level of pertinent WHO recommendations. Even though well over 80% of the subjects was allocated into the moderate and high-level categories, specific WHO recommendations were met by 4.2% of them only.

The results of research on physical activity pursued within a population, as conducted in Europe, revealed that a majority of respondents failed to comply with WHO recommendations on physical activity,[18, 25-31].

Around one quarter of the European population does not follow WHO recommendations on physical activity, which might be attributable to certain inequalities between respective countries, as well as to the ones encountered within them,[32]. Along with a diversity of ongoing changes in man's immediate environment, significant changes in people's lifestyle are simply inevitable. Civilisational progress accompanied by all-embracing automation and mechanization in all major areas of life have appreciably contributed to overall reduction of people's physical activity. Research into physical activity has highlighted several factors that actually differentiate people's approach to this issue, e.g. age, gender, individual health condition, individual motivation,[33].

Considering the differences in the level of physical activity pursued across the Western and Central and Eastern European countries, it seems prudent enough to have the programmes aimed at promoting individual physical activity designed and structured on a local level. Failure to pursue a health-promoting lifestyle by the study

participants was often owed not so much to individual ill will, as to an interplay of several environmental factors characteristic for a specific socio-ecological paradigm. This approach would then stand a far better chance of actually reaching out to the least physically active population groups. Taking into account the differences in compliance with WHO specific recommendations on physical activity, it would also be advisable to consider whether these guidelines should actually be addressed to all social strata within the same scope. Current WHO recommendations take into account the age factor only. In the light of the latest research, it would seem rather prudent to assume that a number of other socio-economic factors acknowledged to impact individual level of physical activity, e.g. gender, education, type of occupation, economic status, region of residence, also be granted due consideration. Assessment of health-promoting paradigms helps identify prevalent perception of health issues, depending on the respondents' specific positioning within a social structure. Disregarding those other factors by WHO may well inadvertently become instrumental in the non-compliance with its recommendations on physical activity in respective European countries, especially across Central and Eastern Europe. About 40% of 53 European countries have never developed their own guidelines on physical activity in which the specific WHO recommendations would be reflected to some extent. This group comprises Poland and the countries of Central and Eastern Europe,[34].

Following their systemic transformation in the early 1990s, the countries of Central and Eastern Europe strive to match overall quality of life in Western Europe. As a result of embracing wholesale consumerism, physical activity as a lifestyle factor has been pushed to a much more inferior position in an order of life's priorities. Besides, state-of-the-art technological advances and brand-new social trends emerging in the

developing countries make sedentary lifestyle steadily more and more common across Central and Eastern Europe. WHO indicates that hypokinesia and sedentary lifestyle are deemed legitimate risk factors for lifestyle diseases,[35].

With a view to appreciably increasing the chances for compliance with WHO recommendations on physical activity, overall public awareness of an appreciably advantageous effect of physical activity on individual health status should definitely be raised. Owing to social, cultural and economic differences encountered between Western and Eastern Europe, specific recommendations on physical activity should be developed on a local level.

It is rather hard to determine whether the WHO recommendations are obsolete, or whether the countries of Central and Eastern Europe have not as yet reached that particular stage of development whereupon their implementation has become a standard lifestyle requirement. In order to take up this challenge, it is vital to establish the actual level of physical activity and the nature of the relationship between physical activity and specific socio-economic factors within a particular locality, and consequently have the recommendations on physical activity effectively adapted to the specific needs of a local population.

Further research is required, with a view to identifying potential environmental factors specific to a particular region/locality, which could account for the differences in population behavioural models, especially in relation to physical activity across Europe at large.

Study limitations

One of the more obvious drawbacks was that the study protocol did not provide for any verification of an individual physical activity through objective assessment methods (e.g. accelerometer, pedometer). Even though the recruitment process, based on voluntary participation, never affected the intrinsic value of the study outcomes, due caution is still recommended in their interpretation. As the study design did not envisage any follow-up, either, there was no opportunity to establish whether the very fact of addressing the survey questionnaire by the respondents may have in any way affected their individual lifestyles, e.g. encourage them to take up any type of regular physical activity.

Conclusion

The results yielded by the present study indicate that despite undertaking a moderate level of physical activity, the residents of a mid-sized, Central-European city, i.e. study participants failed to comply with WHO recommendations on physical activity in leisure time. The level of physical activity and compliance with WHO recommendations were determined by socio-economic factors, e.g. gender, age, education, marital status, and the net monthly income per household. The effect of each of these factors, however, was by no means discrete; they either complemented or eliminated one another. Individual factors may affect overall physical activity level either favourably or adversely.

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Footnotes

Contributors

PM – conceptualization, formal analysis, investigation, methodology, project administration, resources, supervision, writing - review & editing

MTD – data curation, formal analysis, project administration, resources, software, validation, writing - original draft

MZ – conceptualization, formal analysis, investigation, methodology, validation, writing - original draft, writing - review & editing.

MB – software, funding acquisition, supervision, resources

PC – funding acquisition, software, supervision, visualization

HK – data curation, project administration, resources

JSK – data curation, project administration, resources

SG – formal analysis, funding acquisition, investigation, supervision, validation, visualization, writing - original draft.

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The authors represent and warrant that no competing interests exist whatsoever.

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The present study was duly approved by a local Ethics Review Committee, Faculty of Health Sciences (Approval Ref. No. 25/2015), The Jan Kochanowski University (JKU), Kielce, Poland.

Availability of data and material:

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

Data sharing statement: Interview guide and codebook available by request to the corresponding author.

Exclusive Licence:

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6
		(*b*)*Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	8

		(*e*) Describe any sensitivity analyses	

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	9-10
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10-11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	13-15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21-22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

WHO recommendations on physical activity vs. compliance rate within a mid-sized, Central-European city