BMJ
open

Physical activity in south Germany: a cross-sectional study of an urban population

SCHOLARONE™
Manuscripts

Physical activity in south Germany: a cross-sectional study of an urban population

Elli Rupps [a], Mark M Haenle [a], Juergen Steinacker [b], Richard A. Mason [c], Suemeyra Oeztuerk [a], Ronald Steiner [b], *Wolfgang Kratzer [a] and the EMIL-Study group

[a] Department of Internal Medicine I, University Hospital Ulm, Albert-Einstein-Allee 23, 89081 Ulm, Germany

[b] Division of Sports and Rehabilitation, Department of Internal Medicine II, University Hospital Ulm, Steinhoevelstr. 9, 89070 Ulm, Germany

[c] Louis Stokes Cleveland Department of Veterans Affairs Medical Center, Brecksville Division, 10000 Brecksville Road, Brecksville, Ohio 44141, USA

* Corresponding author

Prof. Dr. W. Kratzer
Universitätsklinikum Ulm
Zentrum für Innere Medizin
Klinik für Innere Medizin I
Albert-Einstein-Allee 23
89081 Ulm
Germany

Tel.: +49 731 500 44730
Fax: +49 731 500 44620
Email: wolfgang.kratzer@uniklinik-ulm.de

ABSTRACT

Objectives

The aim of this study was to investigate the degree of leisure time physical activity and self-assessment of physical fitness and relationship to health- and behaviour-specific factors in a randomly selected sample of an urban population in south Germany.

Design setting and participants

A cross-sectional analysis of 2187 randomly selected subjects (52.1% females and 47.9% males) aged 18-65 years participating in the EMIL-study. Individuals were surveyed regarding physical activity, alcohol and tobacco use in a standardized interview. In addition, laboratory, ultrasound and anthropometric data were complied. Adjusted findings were assessed using a logistic regression analysis.

Results

Overall, 38.9% of the participants reported no physical exercise. Men reported a higher level of physical exercise than women. Less exercise was reported by subjects with diabetes, high BMI (Body-mass index) and WHR (Waist-to-hip ratio), and by those who were underweight. Alcohol consumption, smoker status and higher educational level showed a positive association with physical exercise. A negative trend with respect to moderate physical exercise was observed for those with metabolic syndrome, diabetes, hypertension and hepatic steatosis, but this was only significant for subjects with diabetes. In both men and women, there was a relationship between self-assessed "good" PF (physical fitness) and high physical exercise.

Conclusion

Our data show that a large proportion of the study population is not physically active; specific risk groups (overweight subjects, older subjects, smokers or subjects with low educational level) are even less active. The data suggest that there is a great potential for measures promoting physical exercise in these groups.

Summary

Article focus

- To investigate the degree of leisure time physical activity and self-assessment of physical fitness and relationship to health- and behaviour-specific factors in a randomly selected sample of an urban population in south Germany.

Key Message

- Individuals with high educational level are more likely to be physically active.

- Physical activity is more prevalent in men then in women and is inverse associated with BMI.

- There is need of promoting physical exercises for special risk groups.

Strengths and Limitations

- The strengths of this study include its prospective design and the randomly selected study population with its relatively large size and response rate.

- Because of its cross-sectional design, our present study does not identify causal relationships between leisure time physical activity and other factors surveyed.

- Physical activity was surveyed on the basis of subjects' self-reports assessed in a standardized interview and not measured quantitatively.

INTRODUCTION

Physical inactivity is an important behavioural risk factor that is associated with many negative health consequences. Health benefit of regular physical activity relates not only to an improved quality of life but also reduces the risk of a variety of disorders, including overweight, cardiovascular diseases, diabetes mellitus type 2, stroke and osteoporosis. There is also reduction in both cardiovascular and overall mortality.[1-5] Albeit the benefits of regular physical activity are widely known, physical exercise remains low in most industrialized nations as well as in Germany.[6-9] There is a known association of physical exercise with alcohol consumption, non-smoker status and healthy diet.[10-13] These associations, which also point to behaviour-correlated health risks, are important for the planning and implementation of measures promoting health.

Objective of the present study was to assess the level of physical exercise in an urban population and to identify inactive subgroups for future preventive health strategies. A randomly selected population sample was examined prospectively to determine the relationship between body-mass index (BMI), waist-to-hip ratio (WHR), alcohol and tobacco consumption, sonographically assessed hepatic steatosis, sociodemographic and behaviour specific factors, as well as age- and gender-specific differences, and physical activity.

METHODS

Subjects

We conducted in the year of 2002 a population-based, cross-sectional health survey in the city of Leutkirch in south Germany. 4.000 of 12.475 inhabitants of an urban population were randomly selected from the registry of inhabitants and invited to participate in the study. A total of 2.445 persons aged 10–65 years participated in the study. The following analysis considers data derived from 2.187 adult subjects between 18 and 65 years. A more detailed description of subject recruitment has been published elsewhere.[14]

The investigation procedures included a questionnaire interview, anthropometric measurements, blood sample collection and an ultrasound examination. Each investigation was conducted by a trained interviewer. The questionnaire included personal data (date of birth, gender, education, diseases), health behaviour (i. e. sports), and other risk factors for diseases (i.e. smoking). In order to validate the results, multiple cross-checked questions on the same topic were addressed to the participants. The interview was partially based on validated instruments from other studies (e.g. alcohol questions from the MONICA Study).[15]

The study meets the international agreements of the Helsinki Declaration from 1996 and was approved by the research Ethics Committee of the Baden-Württemberg General Medical Council (Landesärztekammer Baden-Württemberg).

Assessment of Physical activity

Physical activity was assessed using questions modified from the MONICA/KORA study and from the questionnaire of Voorips et al.[3, 9, 16] Participants were asked how many hours per week they were physically active. Based on this information, subjects were categorized into groups who reported "0-2 hours", "2-4 hours", "4-10 hours" or "> 10 hours" of physical exercise per week. Those who did not declare physical activity were defined as "physically inactive". Three groups were formed for multivariate analysis: subjects with "moderate" (0-4 hours per week), "high" (more than 4 hours per week) and "no" physical exercise. Subjects were also asked to rate their own physical fitness (PF) on a scale of 0 ("not at all") to 10 ("very fit") using a visual analogue scale provided by the interviewer. Based on these responses, subjects were classified according to "good" (7-10), "moderate" (4-6) and "poor" (0-3) PF.

Anthropometry, Laboratory tests and Ultrasonography

Based on recommendations of the WHO,[17] we determined subjects' height, body weight, hip and waist circumference. Underweight, normal weight, overweight and obesity were defined as follows: underweight = BMI < 18.5 kg/m²; normal weight = BMI 18.5 - < 25 kg/m²; overweight = BMI 25 - < 30 kg/m²; obesity, grade I = BMI 30 - < 35 kg/m²; obesity, grade II = BMI 35 - < 40 kg/m²; obesity, grade III = BMI > 40 kg/m².

Laboratory testing included analytical clinical chemistry for serum or plasma levels of triglycerides, cholesterol, LDL and HDL were determined using the Dimension XL (Dade Behring Inc., Newark, DE, USA). As far as possible, tests were conducted according to the guidelines of the IFCC (International Federation of Clinical Chemistry and Laboratory

Medicine). Total cholesterol levels above 5.2 mmol/l were considered elevated. Triglycerides were considered elevated at 2.3 mmol/l or above.

Ultrasonographic examination of the liver was performed using four identical ATL/Philips HDI 5000 ultrasound scanners (ATL Ultrasound, Philips Medical Systems, P.O. Box 3003, Bothell, WA 98041-3003, USA) with identical settings and a 2-5 MHz probe. Assessment of hepatic steatosis was performed using criteria established by Saverymutu et al.[18]

For the present study, metabolic syndrome was diagnosed when subjects met at least three of the following five criteria modified from ATP III:[19] obesity with a BMI > 30 kg/m²; serum triglycerides > 1.7 mmol/L; HDL < 1.0 mmol/L (males) or < 1.2 mmol/L (females); history of arterial hypertension; random blood glucose > 8.9 mmol/L and/or history of diabetes mellitus.

Statistics

Absolute and relative frequencies were calculated for qualitative factors in the descriptive-statistical analysis, while, for quantitative factors, mean and standard deviation, as well as median, minimum and maximum were calculated.

The multivariate analysis was performed using a logistic regression model. Correlation of moderate to high physical exercise with sociodemographic, behavior-specific and health-relevant factors as well as with subjects' PF was determined and evaluated using Odds ratios (OR) and 95% confidence interval (CI) derived from the logistic regression analysis. In order to make representative statements, data was adjusted for gender, age, BMI, educational level, tobacco and alcohol consumption.

The statistical evaluation was performed using the SAS 9.2 statistical software program.

RESULTS

Overall, 38.9% of subjects reported no physical exercise. High physical activity was significantly more prevalent among men in comparison with women (OR = 2.05; CI = 1.46-2.87) and had a negative correlation with age (Table 1). Subjects with high BMI and those who were underweight reported less physical activity than did subjects of normal body weight. For WHR, there was a negative correlation with moderate (OR = 0.73; CI = 0.62-0.87) and high (OR = 0.64; CI = 0.48-0.87) physical activity.

Table 1. Association of physical activity with sociodemographic, anthropometric, and laboratory factors.

	Sports / Exercise N (%)			OR and 95%-CI[†]	
	No	moderate	High	moderate vs no PA	high vs no PA
Study Population N[*] (%)	847 (39)	1067 (49)	259 (12)		
Gender					
Female	446 (41)	561 (51)	93 (9)	References	References
Male	378 (38)	467 (47)	155 (16)	0.94 (0.76-1.16)	2.05 (1.46-2.87)[‡]
Age					
18-30	134 (34)	182 (46)	81 (20)	References	References
31-40	217 (39)	283 (51)	53 (10)	1.00 (0.74-1.36)	0.44 (0.28-0.70)[‡]
41-50	180 (37)	257 (53)	50 (10)	1.11 (0.81-1.53)	0.59 (0.37-0.95)[‡]
51-65	293 (44)	306 (46)	64 (10)	0.96 (0.70-1.31)	0.54 (0.34-0.86)[‡]
BMI (kg/m2)					
Underweight (< 18.5)	23 (44)	27 (52)	2 (4)	0.78 (0.43-1.42)	0.19 (0.04-0.89)[‡]
Normal (18.5 ≤ 25)	325 (33)	520 (52)	147 (15)	References	References
Overweight (25 ≤ 30)	278 (41)	332 (49)	72 (11)	0.81 (0.64-1.02)	0.57 (0.40-0.82)[‡]
Adipositas (≥ 30)	198 (53)	149 (40)	27 (7)	0.55 (0.42-0.72)[‡]	0.34 (0.21-0.55)[‡]
Waist-to-Hip Ratio					
Per 0.1 item	824 (39)	1027 (49)	248 (12)	0.73 (0.62-0.87)[‡]	0.64 (0.48-0.87)[‡]
Educational achievement					
No education	39 (81)	7 (15)	2 (4)	0.27 (0.12-0.62)[‡]	0.36 (0.08-1.57)
CSE equivalent	458 (49)	396 (42)	81 (9)	References	References
GCSE equivalent	203 (33)	338 (54)	80 (13)	1.78 (1.41-2.25)[‡]	1.94 (1.32-2.85)[‡]
A-Levels equivalent	118 (26)	270 (59)	73 (16)	2.35 (1.80-3.06)[‡]	2.74 (1.83-4.09)[‡]
Smoking					
Current smoker	299 (47)	275 (43)	60 (10)	0.65 (0.51-0.82)[‡]	0.45 (0.31-0.66)[‡]
Ex-smoker	174 (35)	264 (53)	65 (13)	1.11 (0.86-1.43)	0.99 (0.67-1.46)
Non-smoker	351 (37)	489 (51)	123 (13)	References	References
Alcohol consumption					
Ex-consumer	41 (47)	36 (41)	10 (12)	1.19 (0.72-1.97)	1.32 (0.60-2.93)
No consumption	329 (47)	296 (43)	71 (10)	References	References

	Sports / Exercise N (%)			OR and 95%-CI[†]	
	No	moderate	High	moderate vs no PA	high vs no PA
0-20g / Day	317 (35)	469 (52)	110 (12)	1.47 (1.18-1.85) [‡]	1.40 (0.96-2.04)
21-40g / Day	82 (30)	153 (56)	39 (14)	2.00 (1.43-2.80) [‡]	1.99 (1.18-3.33) [‡]
>40g / Day	55 (37)	74 (50)	18 (12)	1.69 (1.11-2.58) [‡]	1.40 (0.72-2.72)
Metabolic Syndrome					
No	723 (38)	955 (50)	229(12)	References	References
Yes	74 (56)	45 (34)	13 (10)	0.72 (0.46-1.13)	1.32 (0.61-2.83)
Steatosis hepatis					
No	534 (36)	757 (51)	191 (13)	Reference	References
Grade I	98 (43)	115 (50)	17 (7)	0.99 (0.72-1.38)	0.76 (0.41-1.39)
Grade II and III	182 (49)	152 (41)	40 (11)	0.76 (0.55-1.04)	0.88 (0.53-1.45)
Diabetes					
No	789 (39)	1009 (50)	239 (12)	References	References
Yes	33 (57)	16 (28)	9 (16)	0.45 (0.24-0.86) [‡]	1.11 (0.48-2.60)
Hypertension					
No	654 (37)	878 (50)	215 (12)	References	References
Yes	159 (49)	135 (41)	32 (10)	0.79 (0.59-1.05)	0.99 (0.61-1.62)
HDL					
Normal	656 (38)	864 (50)	210 (12)	References	References
Pathologic**	140 (48)	121 (41)	31 (11)	0.88 (0.66-1.17)	0.92 (0.57-1.48)
LDL					
Normal	561 (39)	689 (48)	173 (12)	References	References
Pathologic**	137 (42)	157 (48)	31 (10)	1.01 (0.77-1.33)	0.76 (0.48-1.21)
Triglyceride					
Normal	500 (38)	663 (50)	156 (12)	References	References
Pathologic**	264 (45)	257 (44)	69 (12)	0.83 (0.66-1.05)	0.96 (0.66-1.41)
Cholesterin					
Normal	306 (39)	369 (47)	105 (14)	References	References
Pathologic**	511 (39)	644 (50)	141 (11)	1.11 (0.90-1.38)	1.04 (0.74-1.47)

PA: Physical activity, OR: Odds Ratio, CI: Confidence interval, vs: versus

* Number of the study population (N) before adjustment

** Pathologic parameters: High Density Lipoprotein (HDL) male ≤ 1.0, female ≤ 1.2; Low Density Lipoprotein (LDL) ≥ 4.1; Triglyceride > 1.7; Cholesterin ≥ 5.2 (Parameter in mmol/L).

† Adjusted for sex, age, BMI (Body Mass Index in kg/m^2), educational level, smoking and alcohol consumption;

‡ $P<0.05$

A strong correlation was identified between physical activity and level of educational achievement. Participants with GCSE equivalent (Realschulabschluss) and A-levels equivalent (Abitur) were significantly more active than those with CSE equivalent (Hauptschulabschluss) (OR = 1.94 and 2.74).

Smokers were significantly less physically ac tive than were non-smokers. Alcohol consumption, however, showed a positive association with physical exercise, with the strongest association in the group with daily alcohol consumption of 21-40 grams per day. A negative trend with respect to moderate physical exercise was observed for those with metabolic syndrome, pathological HDL, LDL or triglyceride values, diabetes, hypertension and hepatic steatosis, but this was only significant for subjects with diabetes (OR = 0.45; CI = 0.24-0.86) (Table 1).

Approximately 50% of women and 58% of men estimated their PF as "good", further 44% of women and 37% as "moderate". Only 7% of women and 5% of men rated their PF as "poor". The distribution of subjects' self-assessment of PF was quite uniform across all age groups (Figure 1). In order to determine the influence of physical exercise on the subjective assessment of PF, the group of women and men with self-assessed "good" PF was broken down according to the degree of their physical exercise. In order to assess the effect of age on these results, logistic regression models were calculated. The Odds Ratio of high physical activity level (more than 4 hours per week) associated with "good" physical fitness was 2.6 for men and 3.2 for women (Figure 2, Table 2).

Table 2. Association of physical activity with self-assessed "good" physical fitness

Physical activity	Men		Women	
	OR†	95%-CI	OR†	95%-CI
No	References		References	
0-4 h/week	1.06	0.81 – 1.38	1.17	0.91 – 1.50
>4h/week	2.57	1.69 – 3.90‡	3.21	1.99 – 5.20‡

OR: Odds Ratio, CI: Confidence interval; h: hours

† adjusted for age; ‡ $P < 0.05$

DISCUSSION

The purpose of this study was to assess the prevalence of leisure time physical activity in an urban population of south Germany and explore the specific risk groups for possible intervention programs.

The EMIL study is a population-based cross-sectional study of an urban population in southern Germany. The rate of participation was 62.8% (n = 2.187), which is comparable to other cross-sectional studies.[20, 21] The evaluation of data from the overall population in Leutkirch shows that the study population, because of its large number of participants and also because of its age and gender distribution, is adequately representative of the local population.

The prevalence of inactivity was approximately 39% with significant differences across subgroups. The present study shows that high physical activity is more prevalent in men then in women independent of age, BMI, educational level, tobacco or alcohol consumption. Although the results are not directly comparable to other studies using different questionnaires, the majority of studies report a higher degree of physical exercise among men.[6, 12, 22, 23] Our study identified age differences in physical exercise. The prevalence of inactivity was the highest in the 51-65 years old age group. Although most studies in Europe and the United States [11, 20, 22] report that physical activity declines with age some studies from Asia show a positive association between physical activity and increasing age.[24, 25] This is a result of possibly increased leisure time physical activity participation after retirement.[25] Older people are at a higher risk for disability and reduction in cardiopulmonary capacity, therefore intervention programs should focus more on physical activity opportunities for the elderly.[26]

There were also differences in physical exercise in relation to subjects' educational level. By far the highest degree of physical inactivity was reported in 93% women and 63% men who had not completed any schooling and declines with increasing educational level. In the multivariate analysis, this correlation was shown to be statistically significant for moderate and high physical activity. Several studies have shown a strong negative relationship between prevalence of physical activity and educational level.[3, 24, 27] Among the possible reasons that have been discussed for these observations are health-related attitudes that vary with educational level, as well as differences in health knowledge and forms of social integration.

Our findings agree with a majority of studies indicating an inverse association between physical activity and increasing BMI or waist circumference. Interestingly, underweight women, but not underweight men, were also significantly less physically active.[28, 29]

The results of the present study are in accordance with previous studies, which have shown that physical activity is associated with a reduced risk of Type 2 diabetes.[3, 30, 31, 32] However, we did not show an association between metabolic syndrome and physical activity. Halldin et al.[33] reported a strong negative correlation between physical exercise and metabolic syndrome in 60-year-olds. Other studies from Finland, Great Britain and Mexico using self-reports of physical activity or objective measurements confirm these findings.[34-36] Unlike results of Hsieh et al.[37] our data didn't show a significant difference in the prevalence of hepatic steatosis between physically active and inactive persons.

According to other studies our findings showed that male and female smokers were significantly less physically active than were non-smokers.[3, 38] Participants who drink moderate amounts of alcohol were more physically active than those reporting no

alcohol consumption. A similar observation was reported for the MONICA/KORA study, in which persons with moderate alcohol consumption patterns tended toward a higher activity level than did non-drinkers.[3] Associations with smoking and alcohol consumption may provide evidence for the accumulation of behaviour-correlated health risks. This makes them relevant for planning and implementation of measures for promoting health.

In our study we could show significant differences between self-assessed PF of active and inactive persons. Men and women with higher level of physical activity estimated their PF more frequently as "good" as did those who reported no physical exercise. Although other studies queried subjects' subjective general health status rather than physical fitness, findings were very similar with regard to physical activity. Becker et al.[39] showed that persons with poor subjective assessment of general health were underrepresented in the physically active group. Pan et al.[40] reinforced this result when considering both sexes together. Participants who reported poor health status were less likely to have sufficient physical activity than those who had a good health status. If we compare our self-assessed PF with subjective general health ratings reported by Lampert et al.[7], we find comparable self-assessments and a similar survey method of physical exercise, despite differences in definitions. The findings also showed a relationship between physical activity and self-assessed "very good" general health and significant differences between physically active and inactive subjects. Unlike our data the survey included only persons who denied any chronic disease or physical disorder, therefore it is more probable to associate a health-promoting effect with physical activity.

Because of its cross-sectional design, our present study does not identify causal relationships between leisure time physical activity and other factors surveyed. The results obtained in this study did not include work-related, household and commuting activities, which are not routinely included in physical activity measurements but are also important contributors for total physical activity and could perhaps diminish differences in physical activity levels between genders. Physical activity was surveyed on the basis of subjects' self-reports assessed in a standardized interview and not measured quantitatively. Objective methods such as accelerometers, pedometers or heart rate monitoring are more precise than subjective assessment. However, performing such quantitative measurements in large, population-based studies is difficult and cost-intensive. For this reason most epidemiologists have opted to use questionnaires for this purpose.

The strengths of this study include its prospective design and the randomly selected study population with its relatively large size and response rate. The survey of physical activity, behaviour patterns and medical history, together with laboratory studies and other examinations were performed by specially trained personnel.

In conclusion, the results of the present study show that a large proportion of the population is not physically active. Thus, the potential for measures promoting physical exercise is very high. Special risk groups (older subjects, overweight persons, smokers, persons with low educational achievement) with known low levels of physical activity show a large potential for measures promoting physical exercise.

ACKNOWLEDGEMENTS

COMPETING INTERESTS

FUNDING

AUTHOR'S CONTRIBUTION

1) Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data: Rupps E, Haenle MM, Steiner R, Oeztuerk S, Steinacker J, Kratzer W

2) Drafting the article or revising it critically for important intellectual content: Rupps E, Mason RA, Haenle MM, Steiner R, Oeztuerk S, Steinacker J, Kratzer W

3) Final approval of the version to be published: Kratzer W, Haenle MM

DATA SHARING STATEMENT

There is no additional data available.

References

1. Littman AJ, Kristal AR, White E. Effects of physical activity intensity, frequency, and activity type on 10-y weight change in middle-aged men and women. Int J Obes (Lond) 2005;29**:**524–33.

2. Hill JO, Wyatt HR. Role of physical activity in preventing and treating obesity. J Appl Physiol 2005;99**:**765–70.

3. Meisinger C, Löwel H, Thorand B, et al. Leisure time physical activity and the risk of type 2 diabetes in men and women from the general population. The MONICA/KORA Augsburg Cohort Study. Diabetologia 2005;48**:**27–34.

4. Hu G, Sarti C, Jousilahti P, et al. Leisure time, occupational, and commuting physical activity and the risk of stroke. Stroke 2005;36**:**1994–9.

5. Hu G, Tuomilehto J, Silventoinen K, et al. The effects of physical activity and body mass index on cardiovascular, cancer and all-cause mortality among 47 212 middle-aged Finnish men and women. Int J Obes (Lond) 2005;29**:**894–902.

6. Schaller N, Seiler H, Himmerich S, et al. Estimated physical activity in Bavaria, Germany, and its implications for obesity risk: results from the BVS-II Study. Int J Behav Nutr Phys Act 2005;2:6.

7. Lampert T, Mensink GBM, Ziese T. Sport and health among adults in Germany. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 2005;48**:**1357–64.

8. Rütten A, Abu-Omar K, Lampert T, et al. Körperliche Aktivität. Gesundheitsberichterstattung des Bundes, Robert Koch Institut, 2005;26**:**7–13.

9. Meisinger C, Löwel H, Heier M, et al. Association of sports activities in leisure time and incident myocardial infarction in middle-aged men and women from the general population: the MONICA/KORA Augsburg cohort study. Eur J Cardiovasc Prev Rehabil 2007;14**:**788–92.

10. Dowda M, Ainsworth BE, Addy CL, et al. Correlates of physical activity among U.S. young adults, 18 to 30 years of age, from NHANES III. Ann Behav Med 2003;**26:**15–23.

11. Kaplan MS, Newsom JT, McFarland BH, et al. Demographic and psychosocial correlates of physical activity in late life. Am J Prev Med 2001;21**:**306–12.

12. Pitsavos C, Panagiotakos DB, Lentzas Y, et al. Epidemiology of leisure-time physical activity in socio-demographic, lifestyle and psychological characteristics of men and women in Greece: the ATTICA Study. BMC Public Health 2005;5**:**37.

13. Park SY, Murphy SP, Wilkens LR, et al. Dietary patterns using the Food Guide Pyramid groups are associated with sociodemographic and lifestyle factors: the multiethnic cohort study. J Nutr 2005;135**:**843–9.

14. Haenle MM, Brockmann SO, Kron M, et al. Overweight, physical activity, tobacco and alcohol consumption in a cross-sectional random sample of German adults. BMC Public Health 2006;6**:**233.

15. Imhof A, Woodward M, Doering A, et al. Overall alcohol intake, beer, wine, and systemic markers of inflammation in western Europe: results from three MONICA samples (Augsburg, Glasgow, Lille). European Heart Journal 2004;25**:**2092-100.

16. Voorrips LE, Ravelli AC, Dongelmans PC, et al. A physical activity questionnaire for the elderly. Med Sci Sports Exerc 1991;23**:**974–9.

17. WHO: Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser 1995;854**:**427–37.

18. Saverymuttu SH, Joseph AE, Maxwell JD. Ultrasound scanning in the detection of hepatic fibrosis and Steatosis. Br Med J (Clin Res Ed) 1986;292**:**13-5.

19. Boehm BO, Claudi-Boehm S, Yildirim S, et al. Prevalence of the metabolic syndrome in southwest Germany. Scand J Clin Lab Invest Suppl 2005;240:122–8.

20. Sternfeld B, Ainsworth BE, Quesenberry CP. Physical activity patterns in a diverse population of women. Prev Med 1999;28**:**313–23.

21. Gal DL, Santos AC, Barros H. Leisure-time versus full-day energy expenditure: a cross-sectional study of sedentarism in a Portuguese urban population. BMC Public Health 2005;5**:**16.

22. Martínez-González MA, Varo JJ, Santos JL, et al. Prevalence of physical activity during leisure time in the European Union. Med Sci Sports Exerc 2001;33**:**1142–6.

23. Azevedo MR, Araújo CL, Reichert FF, et al. Gender differences in leisure-time physical activity. Int J Public Health 2007;52:8-15.

24. Jurj AL, Wen W, Gao YT, et al. Patterns and correlates of physical activity: a cross-sectional study in urban Chinese women. BMC Public Health 2007;7**:**213.

25. Chen YJ, Huang YH, Lu FH, et al. The correlates of leisure time physical activity among an adults population from southern Taiwan. BMC Public Health 2011;11:427.

26. Lacour JR, Kostka T, Bonnefoy M. Physical activity to delay the effects of aging on mobility. Presse Med 2002;31:1185–92.

27. Drygas W, Kwasniewska M, Kaleta D, et al. Epidemiology of physical inactivity in Poland: prevalence and determinants in a former communist country in socioeconomic transition. Public health 2009;123:592-7.

28. Aadahl M, Kjaer M, Jørgensen T. Associations between overall physical activity level and cardiovascular risk factors in an adult population. Eur J Epidemiol 2007;22:369-78.

29. Ball K, Owen N, Salmon J, et al. Associations of physical activity with body weight and fat in men and women. Int J Obes Relat Metab Disord 2001;25:914-9.

30. Hu G, Qiao Q, Silventoinen K, et al. Occupational, commuting, and leisure-time physical activity in relation to risk for Type 2 diabetes in middle-aged Finnish men and women. Diabetologia 2003;46**:**322–9.

31. Hu FB, Li TY, Colditz GA, et al. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA 2003;289:1785-91.

32. Hu FB, Leitzmann MF, Stampfer MJ, et al. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch Intern Med 2001;161:1542-8.

33. Halldin M, Rosell M, de Faire U, et al. The metabolic syndrome: prevalence and association to leisure-time and work-related physical activity in 60-year-old men and women. Nutr Metab Cardiovasc Dis 2007;17**:**349–57.

34. Laaksonen DE, Lakka HM, Salonen JT, et al. Low levels of leisure-time physical activity and cardiorespiratory fitness predict development of the metabolic syndrome. Diabetes Care 2002;25**:**1612–18.

35. Rennie KL, McCarthy N, Yazdgerdi S, et al. Association of the metabolic syndrome with both vigorous and moderate physical activity. Int J Epidemiol 2003;32**:**600–6.
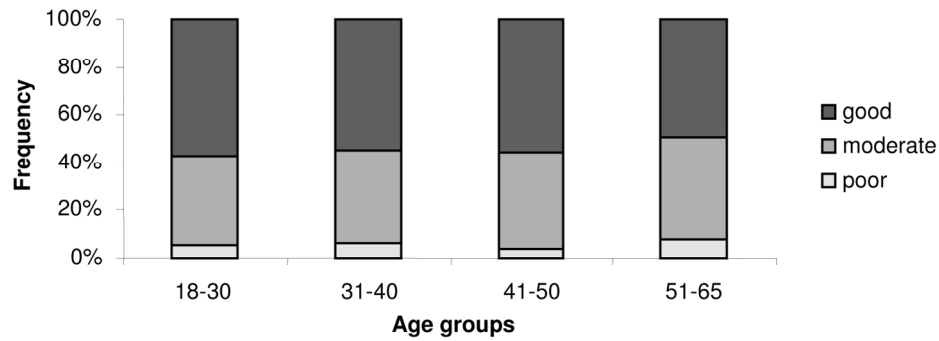
36. Mendez-Hernandez P, Flores Y, Siani C, et al. Physical activity and risk of Metabolic Syndrome in an urban Mexican cohort. BMC Public Health 2009;9**:**276.

37. Hsieh SD, Yoshinaga H, Muto T, et al. Regular physical activity and coronary risk factors in Japanese men. Circulation 1998;97**:**661–5.
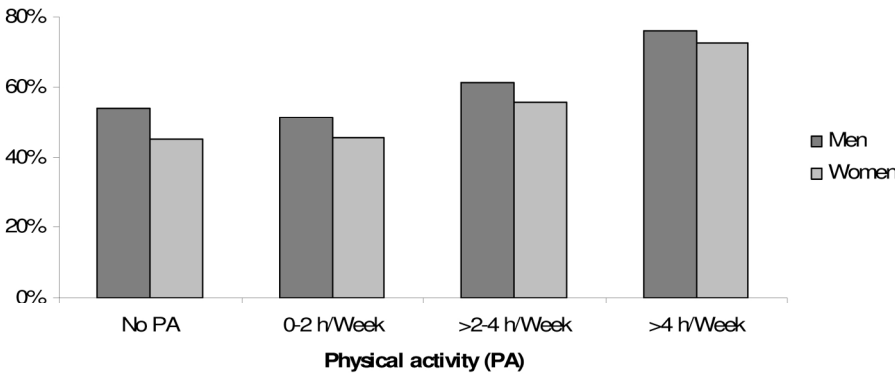
38. Brownson RC, Eyler AA, King AC, et al. Patterns and correlates of physical activity among US women 40 years and older. Am J Public Health 2000;90**:**264–70.

39. Becker S, Huy C, Brinkhoff KP, et al. "Living an active life"- sports, exercise and health in middle-aged and older adults. An empirical database on physical activity, health behavior and lifestyle in the 50- to 70-year-old residential population of Baden-Wuerttemberg. Gesundheitswesen 2007;69**:**401–7.

40. Pan SY, Cameron C, Desmeules M, et al. Individual, social, environmental, and physical environmental correlates with physical activity among Canadians: a cross-sectional study. BMC Public Health 2009;9:21.

Self assessed physical fitness according to age groups
146x60mm (300 x 300 DPI)

Physical activity in women and men with self-assessed "good" Physical Fitness
175x81mm (300 x 300 DPI)

BMJ open

Physical exercise in southern Germany: A cross-sectional study of an urban population

SCHOLARONE™
Manuscripts

Physical exercise in southern Germany: A cross-sectional study of an urban population

Elli Rupps [a], Mark M Haenle [a], Juergen Steinacker [b], Richard A. Mason [c], Suemeyra Oeztuerk [a], Ronald Steiner [b], [*]Wolfgang Kratzer [a] and the EMIL-Study group

[a] Department of Internal Medicine I, University Hospital Ulm, Albert-Einstein-Allee 23, 89081 Ulm, Germany

[b] Division of Sports and Rehabilitation, Department of Internal Medicine II, University Hospital Ulm, Steinhoevelstr. 9, 89070 Ulm, Germany

[c] Louis Stokes Cleveland Department of Veterans Affairs Medical Center, Brecksville Division, 10000 Brecksville Road, Brecksville, Ohio 44141, USA

Corresponding author

Prof. Dr. W. Kratzer
Universitätsklinikum Ulm
Zentrum für Innere Medizin
Klinik für Innere Medizin I
Albert-Einstein-Allee 23
89081 Ulm
Germany

Tel.: +49 731 500 44730
Fax: +49 731 500 44620
Email: wolfgang.kratzer@uniklinik-ulm.de

ABSTRACT

Objectives

The aim of this study was to investigate the degree of physical exercise and self-assessment of physical fitness, and their relationship to health- and behaviour-specific factors in a randomly selected sample of an urban population in southern Germany.

Design

Cross-sectional study.

Setting

In the southern German city of Leutkirch.

Participants

2187 subjects randomly selected from the registry of inhabitants. Of the selected group, aged 18-65 years, 52.1% were females and 47.9% males.

Primary and secondary outcome measures

Participants were asked how many hours per week they spent on physical exercise and sports. They were also asked to rate their own performance and/or physical fitness.

Results

Overall, 38.9% of the participants reported no physical exercise. Men reported a higher level of physical exercise than did women. Less exercise was reported by subjects with diabetes, high BMI (body-mass index) and WHR (waist-to-hip ratio), and by those who were underweight. Alcohol consumption, smoker status and higher educational level showed a positive association with physical exercise. A negative trend with respect to moderate physical exercise was observed for those with metabolic syndrome, diabetes, hypertension and hepatic steatosis, but this was statistically significant only for subjects

with diabetes. In both men and women, there was a relationship between self-assessed "good" PF (physical fitness) and high physical exercise.

Conclusions

Our data show that a large proportion of the study population is not physically active; specific risk groups (overweight subjects, older subjects, smokers or subjects with low educational level) are even less active. The data suggest that there is a great potential for measures promoting physical exercise in these groups.

Summary

Article focus

- To investigate the degree of physical exercise and self-assessment of physical fitness and relationship to health- and behaviour-specific factors in a randomly selected sample of an urban population in southern Germany.

Key Message

- Individuals with high educational level are more likely to be physically active.

- Physical exercise is more prevalent in men then in women and is inversely associated with BMI.

- There is need of promoting physical exercise particularly for special risk groups.

Strengths and Limitations

- The strengths of this study include the randomly selected study population with its relatively large size and response rate.

- Because of its cross-sectional design, our present study does not identify causal relationships between physical exercise and other factors surveyed.

- Physical exercise was surveyed on the basis of subjects' self-reports assessed in a standardized interview and not measured quantitatively.

INTRODUCTION

Physical inactivity is an important behavioural risk factor that is associated with many negative health consequences. The health benefit of regular physical activity relates not only to an improved quality of life but also reduces the risk of a variety of disorders, including overweight, cardiovascular diseases, diabetes mellitus type 2, stroke and osteoporosis. There is also reduction in both cardiovascular and overall mortality.[1-5] Although the benefits of regular physical activity are widely known, physical exercise remains low in Germany as in most industrialized nations.[6-9] There is a known association of physical exercise with alcohol consumption, non-smoker status and healthy diet.[10-13] These associations, which also point to behaviour-correlated health risks, are important for the planning and implementation of measures promoting health.

Objective of the present study was to assess the level of physical exercise in an urban population and to identify inactive subgroups for future preventive health strategies. A randomly selected population sample was examined to determine the relationship between body-mass index (BMI), waist-to-hip ratio (WHR), alcohol and tobacco consumption, sonographically assessed hepatic steatosis, sociodemographic and behaviour specific factors, as well as age- and gender-specific differences, and physical exercise.

METHODS

Subjects

In 2002, we conducted a population-based, cross-sectional health survey in the southern German city of Leutkirch (EMIL-study).[14] A total of 4,000 of 12,475 persons of an urban population were randomly selected from the registry of inhabitants and invited to participate in the study. Of those invited, 2,445 persons aged 10-65 years participated in the study (participation rate: 62.8%). Following exclusion of minors (age < 18 years; n = 258) and those not providing responses regarding the exercise activities (n = 17), a total 2,173 subjects aged 18-65 years were included in the present analysis. A more detailed description of subject recruitment has been published elsewhere.[14]

Subjects participated in a structured interview (questionnaire), and underwent anthropometric measurements, blood sample collection and an ultrasound examination. Each investigation was conducted by a trained interviewer. The questionnaire included personal data (e.g. date of birth, gender, education, medical history), health behaviour (e.g. exercise), and other risk factors for disease (e.g. smoking). In order to validate the results, multiple cross-checked questions on the same topic were addressed to the participants. The interview was partially based on validated instruments from other studies (e.g. alcohol questions from the MONICA Study).[15] The study met the international guidelines of the 1996 Helsinki Declaration and was approved by the Research Ethics Committee of the Baden-Württemberg State Medical Council (Landesärztekammer Baden-Württemberg).

Assessment of physical exercise

Physical exercise was assessed using questions modified from the MONICA/KORA study and from the questionnaire of Voorips et al.[3, 9, 16] Participants were asked how many hours per week they spent on physical exercise and sports (0-2 hours, 2-4 hours, 4-10 hours, >10 hours). Those who did not report physical exercise were defined as physically inactive. Three groups were formed for multivariate analysis: subjects with "high" (more than 4 hours per week), "moderate" (0-4 hours per week) and "no" physical exercise.

Subjects were also asked to rate their own performance and/or physical fitness (PF) on a scale of 0 ("not at all") to 10 ("very fit") using a visual analogue scale (VAS) provided by the interviewer. Based on these responses, subjects' PF was classified according to "good" (7-10), "moderate" (4-6) and "poor" (0-3).

Anthropometry

Based on WHO recommendations,[17] we determined subjects' height, body weight, hip and waist circumference. Underweight, normal weight, overweight and obesity were defined as follows: underweight = BMI < 18.5 kg/m²; normal weight = BMI 18.5 - < 25 kg/m²; overweight = BMI 25 - < 30 kg/m²; obesity, grade I = BMI 30 - < 35 kg/m²; obesity, grade II = BMI 35 - < 40 kg/m²; obesity, grade III = BMI > 40 kg/m².

Laboratory measurements

Laboratory testing included analytical clinical chemistry for serum or plasma levels of triglycerides, total cholesterol and high-density lipoprotein (HDL) cholesterol (Dimension XL; Dade Behring Inc., Newark, DE, USA). As far as possible, tests were conducted

according to the guidelines of the IFCC (International Federation of Clinical Chemistry and Laboratory Medicine). Low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula.[18] Following reference ranges were used in assessing subjects' laboratory findings: total cholesterol < 5.2 mmol/l; triglycerides < 2.3 mmol/l; LDL-cholesterol < 4.1 mmol/l and HDL-cholesterol > 1.0 (males) and > 1.2 (females).

Metabolic syndrome

For purposes of the present study, metabolic syndrome was diagnosed when subjects met at least three of the following five criteria modified from ATP III: obesity with a BMI > 30 kg/m²; serum triglycerides > 1.7 mmol/L; HDL < 1.0 mmol/L (males) or < 1.2 mmol/L (females); history of arterial hypertension; random blood glucose > 8.9 mmol/L and/or history of diabetes mellitus.[19] Data on hypertension and diabetes were assessed from subjects' past medical history.

Ultrasonography

Ultrasonographic examination of the liver was performed using four identical ATL/Philips HDI 5000 ultrasound scanners (ATL Ultrasound, Philips Medical Systems, Bothell, WA, USA) with identical settings and a 2-5 MHz probe. Assessment of hepatic steatosis was performed using criteria established by Saverymutu et al.[20]

Statistics

Absolute and relative frequencies were calculated for qualitative factors in the descriptive-statistical analysis, while, for quantitative factors, mean and standard deviation, as well as median, minimum and maximum were calculated.

The multivariate analysis was performed using a logistic regression model. Association of moderate to high physical exercise with sociodemographic, behaviour-specific and health-relevant factors as well as with subjects' PF was determined and evaluated using Odds ratios (OR) and 95% confidence interval (CI) derived from the logistic regression analysis. In order to make representative statements, data was adjusted for gender, age, BMI, educational level, tobacco and alcohol consumption.

The statistical evaluation was performed using the SAS 9.2 statistical software program.

RESULTS

Overall, 38.9% of subjects reported no physical exercise. High physical exercise was significantly more prevalent among men compared with women (OR = 2.05; CI = 1.46-2.87) and had a negative association with age (Table 1). Subjects with high BMI and those who were underweight reported less physical exercise than did subjects of normal body weight. For WHR, there was a negative association with moderate (OR = 0.73; CI = 0.62-0.87) and high (OR = 0.64; CI = 0.48-0.87) physical exercise.

Table 1. Association of physical exercise with anthropometric factors

	Exercise N(%)			OR (95%-CI) *	
	No	**Moderate**	**High**	**Moderate vs. no PE**	**High vs. no PE**
Gender					
Female	446 (41)	561 (51)	93 (9)	References	References
Male	378 (38)	467 (47)	155 (16)	0.94 (0.76-1.16)	2.05 (1.46-2.87)[‡]
Age					
18-30	134 (34)	182 (46)	81 (20)	References	References
31-40	217 (39)	283 (51)	53 (10)	1.00 (0.74-1.36)	0.44 (0.28-0.70)[‡]
41-50	180 (37)	257 (53)	50 (10)	1.11 (0.81-1.53)	0.59 (0.37-0.95)[‡]
51-65	293 (44)	306 (46)	64 (10)	0.96 (0.70-1.31)	0.54 (0.34-0.86)[‡]
BMI (kg/m²)					
Underweight (< 18.5)	23 (44)	27 (52)	2 (4)	0.78 (0.43-1.42)	0.19 (0.04-0.89)[‡]
Normal (18.5 < 25)	325 (33)	520 (52)	147 (15)	References	References
Overweight (25 < 30)	278 (41)	332 (49)	72 (11)	0.81 (0.64-1.02)	0.57 (0.40-0.82)[‡]
Adipositas (≥ 30)	198 (53)	149 (40)	27 (7)	0.55 (0.42-0.72)[‡]	0.34 (0.21-0.55)[‡]

* Adjusted for sex, age, BMI (Body Mass Index in kg/m²), educational level, tobacco smoking and alcohol consumption;

‡ $P<0.05$

PE: Physical exercise, OR: Odds Ratio, CI: confidence interval, vs: versus

A strong association was identified between physical exercise and level of educational achievement. Participants with GCSE equivalent (*Realschulabschluss*) and A-level

equivalent (*Abitur*) were significantly more active than those with CSE equivalent (*Hauptschulabschluss*; OR = 1.94 and 2.74). Smokers were significantly less physically active than were non-smokers. Alcohol consumption, however, showed a positive association with physical exercise, with the strongest association in the group with daily alcohol consumption of 21-40 grams per day (Table 2).

Table 2. Association of physical exercise with behaviour risk factors

	Exercise N(%)			OR (95%-CI) *	
	No	**Moderate**	**High**	**Moderate vs. no PE**	**High vs. no PE**
Educational achievement					
No education	39 (81)	7 (15)	2 (4)	0.27 (0.12-0.62) ‡	0.36 (0.08-1.57)
CSE equivalent	458 (49)	396 (42)	81 (9)	References	References
GCSE equivalent	203 (33)	338 (54)	80 (13)	1.78 (1.41-2.25) ‡	1.94 (1.32-2.85) ‡
A-Levels equivalent	118 (26)	270 (59)	73 (16)	2.35 (1.80-3.06) ‡	2.74 (1.83-4.09) ‡
Smoking					
Current smoker	299 (47)	275 (43)	60 (10)	0.65 (0.51-0.82) ‡	0.45 (0.31-0.66) ‡
Ex-smoker	174 (35)	264 (53)	65 (13)	1.11 (0.86-1.43)	0.99 (0.67-1.46)
Non-smoker	351 (37)	489 (51)	123 (13)	References	References
Alcohol consumption					
Ex-consumer	41 (47)	36 (41)	10 (12)	1.19 (0.72-1.97)	1.32 (0.60-2.93)
No consumption	329 (47)	296 (43)	71 (10)	References	References
0-20g / Day	317 (35)	469 (52)	110 (12)	1.47 (1.18-1.85) ‡	1.40 (0.96-2.04)
21-40g / Day	82 (30)	153 (56)	39 (14)	2.00 (1.43-2.80) ‡	1.99 (1.18-3.33) ‡
>40g / Day	55 (37)	74 (50)	18 (12)	1.69 (1.11-2.58) ‡	1.40 (0.72-2.72)

* Adjusted for sex, age, BMI (Body Mass Index in kg/m^2), educational level, tobacco smoking and alcohol consumption;

‡ *P*<0.05

PE: Physical exercise, OR: Odds Ratio, CI: confidence interval, vs: versus

A negative trend with respect to moderate physical exercise was observed for those with metabolic syndrome, elevated LDL or triglyceride values, lowered HDL values, diabetes, hypertension and hepatic steatosis, but this was only significant for subjects with diabetes (OR = 0.45; CI = 0.24-0.86; Table 3).

Table 3. Association of physical exercise with other risk factors

	Exercise N(%)			OR (95%-CI) †	
	No	Moderate	High	Moderate vs. no PE	High vs. no PE
Metabolic Syndrome					
No	723 (38)	955 (50)	229(12)	References	References
Yes	74 (56)	45 (34)	13 (10)	0.72 (0.46-1.13)	1.32 (0.61-2.83)
Steatosis hepatis					
No	534 (36)	757 (51)	191 (13)	Reference	References
Grade I	98 (43)	115 (50)	17 (7)	0.99 (0.72-1.38)	0.76 (0.41-1.39)
Grade II/III	182 (49)	152 (41)	40 (11)	0.76 (0.55-1.04)	0.88 (0.53-1.45)
Diabetes					
No	789 (39)	1009 (50)	239 (12)	References	References
Yes	33 (57)	16 (28)	9 (16)	0.45 (0.24-0.86) ‡	1.11 (0.48-2.60)
Hypertension					
No	654 (37)	878 (50)	215 (12)	References	References
Yes	159 (49)	135 (41)	32 (10)	0.79 (0.59-1.05)	0.99 (0.61-1.62)
HDL					
Normal	656 (38)	864 (50)	210 (12)	References	References
Reduced	140 (48)	121 (41)	31 (11)	0.88 (0.66-1.17)	0.92 (0.57-1.48)
LDL					
Normal	561 (39)	689 (48)	173 (12)	References	References
Elevated	137 (42)	157 (48)	31 (10)	1.01 (0.77-1.33)	0.76 (0.48-1.21)
Triglyceride					
Normal	500 (38)	663 (50)	156 (12)	References	References
Elevated	264 (45)	257 (44)	69 (12)	0.83 (0.66-1.05)	0.96 (0.66-1.41)
Cholesterin					
Normal	306 (39)	369 (47)	105 (14)	References	References
Elevated	511 (39)	644 (50)	141 (11)	1.11 (0.90-1.38)	1.04 (0.74-1.47)

* Adjusted for sex, age, BMI (Body Mass Index in kg/m^2), educational level, smoking and alcohol consumption;

‡ $P<0.05$

PE: Physical exercise, OR: Odds Ratio, CI: confidence interval, vs: versus, HDL: high density lipoprotein cholesterol, LDL: low density lipoprotein cholesterol

The distribution of subjects' self-assessment of PF was quite uniform across all age groups (Figure 1). Approximately 50% of women and 58% of men estimated their PF as "good"; a further 44% of women and 37% as "moderate". Only 7% of women and 5% of men rated their PF as "poor". In order to determine the influence of physical exercise on

the subjective assessment of PF, the group of women and men with self-assessed "good" PF was broken down according to the degree of their physical exercise and logistic regression, adjusted for age, was performed. The Odds Ratio of high physical exercise level (more than 4 hours per week) associated with "good" physical fitness was 2.6 for men and 3.2 for women (Figure 2, Table 4).

Table 4. Association of physical exercise with self-assessed "good" physical fitness

	Men		Women	
	OR*	**95%-CI**	**OR***	**95%-CI**
Physical exercise				
No	References		References	
0-4 h/week	1.06	0.81 – 1.38	1.17	0.91 – 1.50
>4h/week	2.57	1.69 – 3.90‡	3.21	1.99 – 5.20‡

* adjusted for age;

‡ P<0.05

OR: Odds Ratio, CI: Confidence interval; h: hours

DISCUSSION

The purpose of this study was to assess the prevalence of physical exercise in an urban population in southern Germany and explore the specific risk groups for possible intervention programs.

The EMIL study is a population-based cross-sectional study of an urban population in southern Germany. The rate of participation was 62.8% (n = 2,445), which is comparable to other cross-sectional studies.[21, 22]

The prevalence of inactivity was approximately 39% with significant differences across subgroups. The present study shows that high physical exercise is more prevalent in

men than in women, independent of age, BMI, educational level, tobacco or alcohol consumption. Although the results are not directly comparable to other studies using different questionnaires, the majority of studies report a higher degree of physical activity among men.[6, 12, 23, 24] Our study identified age differences in physical exercise. The prevalence of inactivity was the highest in the 51-65 years old age group. Although most studies in Europe and the United States [11, 21, 23] report that physical activity declines with age, some studies from Asia show a positive association between physical activity and increasing age.[25, 26] This is possibly a result of increased leisure time physical activity participation after retirement.[26] Older people are at a higher risk for disability and reduction in cardiopulmonary capacity: hence, intervention programs should focus more on physical activity opportunities for the elderly.[27] Studies of physical activity and leisure time physical acitivity in Bavaria confirm the findings of the present study and show that increased physical actitvity, especially in non-obese women, is associated with a decreased rate of type-2 diabetes mellitus.[3, 6]

There were also differences in physical exercise in relation to subjects' educational level. By far the highest degree of physical inactivity was reported in women (93%) and men (63%) who had not completed formal education and declines with increasing educational level. In the multivariate analysis, this association was shown to be statistically significant for moderate and high physical exercise. Several studies have shown a strong negative relationship between prevalence of physical activity and educational level.[3, 25, 28] Among the possible reasons that have been discussed for these observations are health-related attitudes that vary with educational level, as well as differences in health knowledge and forms of social integration.

Our findings agree with a majority of studies indicating an inverse association between physical activity and increasing BMI or waist circumference. Interestingly, underweight women, but not underweight men, were also significantly less physically active.[29, 30] The results of the present study are in accordance with previous studies, which have shown that physical activity is associated with a reduced risk of Type 2 diabetes.[3, 31, 32, 33] However, we did not show an association between metabolic syndrome and physical exercise. Halldin et al.[34] reported a strong negative association between physical exercise and metabolic syndrome in 60-year-olds. Other studies from Finland, Great Britain and Mexico using self-reports of physical activity or objective measurements confirm these findings.[35-37] Unlike results published by Hsieh et al., our data did not show a significant difference in the prevalence of hepatic steatosis between subjects reporting physical exercise and those who are physically inactive.[38]

In agreement with other studies, our findings showed that male and female smokers were significantly less physically active than were non-smokers.[3, 39] Participants reporting consumption of moderate amounts of alcohol were more physically active than those reporting no alcohol consumption. A similar observation was reported for the MONICA/KORA study, in which persons with moderate alcohol consumption patterns tended toward a higher activity level than did non-drinkers.[3] Associations with smoking and alcohol consumption may provide evidence for the accumulation of behaviour-correlated health risks. This makes them relevant for planning and implementation of measures for promoting health.

Our study showed significant differences between self-assessed PF in active and inactive persons. Men and women with higher levels of physical exercise estimated their PF more frequently as "good" than did those who reported no physical exercise.

Although other studies queried subjects' subjective general health status rather than physical fitness, findings were very similar with regard to physical activity. Becker et al. showed that persons with poor subjective assessment of general health were underrepresented in the physically active group.[40] Pan et al reinforced this result when considering both sexes together.[41] Participants who reported poor general health status were less likely to have sufficient physical activity than did those who had a good general health status. If we compare our self-assessed PF with subjective general health ratings reported by Lampert et al., we find comparable self-assessments and a similar survey method of physical exercise, despite differences in definitions.[7] The findings also showed a relationship between physical activity and self-assessed "very good" general health and significant differences between physically active and inactive subjects. Unlike our data, that survey included only persons who denied any chronic disease or physical disorder, therefore it is more probable to associate a health-promoting effect with physical activity.

Based on the study design, the present study shows certain limitations and weaknesses. Because of its cross-sectional design, our study does not identify causal relationships between physical exercise and other factors surveyed. The results obtained in this study did not include work-related, household and commuting activities, which are not routinely included in physical exercise measurements but are also important contributors to total physical activity and could perhaps diminish the differences in physical exercise levels between genders. Physical exercise was surveyed on the basis of subjects' self-reports assessed in a standardized interview and not measured quantitatively. Self-reported data may result in overestimation, especially in the assessment of physical exercise.[6] Objective methods such as accelerometers, pedometers or heart rate

monitoring are more precise than subjective assessment.[42, 43] However, performing such quantitative measurements in large, population-based studies is difficult and cost-intensive. For this reason most epidemiologists have opted to use questionnaires for this purpose.

The strengths of this study include the randomly selected study population with its relatively large size and response rate. The survey of physical exercise, behaviour patterns and medical history, together with laboratory studies and other examinations were performed by specially trained personnel.

In conclusion, the results of the present study show that a large proportion of the population is not physically active. Thus, the potential benefit of measures promoting physical exercise is very high. Special risk groups (older subjects, overweight persons, smokers, persons with low educational achievement) with known low levels of physical exercise have a particularly large potential for measures promoting physical exercise.

ACKNOWLEDGEMENTS

K, Mertens T, Oehme R, Pfaff G, Piechotowski I, Reuter S, Romig T, von Schmiesing AFA, Steinbach G, Tourbier M, Voegtle A, Walcher T, Wolff S.

COMPETING INTERESTS

None

FUNDING

AUTHOR'S CONTRIBUTION

1) Substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data: Rupps E, Haenle MM, Steiner R, Oeztuerk S, Steinacker J, Kratzer W

2) Drafting the article or revising it critically for important intellectual content: Rupps E, Mason RA, Haenle MM, Steiner R, Oeztuerk S, Steinacker J, Kratzer W

3) Final approval of the version to be published: Rupps E, Mason RA, Haenle MM, Steiner R, Oeztuerk S, Steinacker J, Kratzer W

DATA SHARING STATEMENT

There is no additional data available.

References

1. Littman AJ, Kristal AR, White E. Effects of physical activity intensity, frequency, and activity type on 10-y weight change in middle-aged men and women. Int J Obes (Lond) 2005;29**:**524–33.

2. Hill JO, Wyatt HR. Role of physical activity in preventing and treating obesity. J Appl Physiol 2005;99**:**765–70.

3. Meisinger C, Löwel H, Thorand B, et al. Leisure time physical activity and the risk of type 2 diabetes in men and women from the general population. The MONICA/KORA Augsburg Cohort Study. Diabetologia 2005;48**:**27–34.

4. Hu G, Sarti C, Jousilahti P, et al. Leisure time, occupational, and commuting physical activity and the risk of stroke. Stroke 2005;36**:**1994–9.

5. Hu G, Tuomilehto J, Silventoinen K, et al. The effects of physical activity and body mass index on cardiovascular, cancer and all-cause mortality among 47 212 middle-aged Finnish men and women. Int J Obes (Lond) 2005;29**:**894–902.

6. Schaller N, Seiler H, Himmerich S, et al. Estimated physical activity in Bavaria, Germany, and its implications for obesity risk: results from the BVS-II Study. Int J Behav Nutr Phys Act 2005;2:6.

7. Lampert T, Mensink GBM, Ziese T. Sport and health among adults in Germany. Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz 2005;48**:**1357–64.

8. Rütten A, Abu-Omar K, Lampert T, et al. Körperliche Aktivität. Gesund-heitsberichterstattung des Bundes, Robert Koch Institut, 2005;26**:**7–13.

9. Meisinger C, Löwel H, Heier M, et al. Association of sports activities in leisure time and incident myocardial infarction in middle-aged men and women from the general population: the MONICA/KORA Augsburg cohort study. Eur J Cardiovasc Prev Rehabil 2007;14**:**788–92.

10. Dowda M, Ainsworth BE, Addy CL, et al. Correlates of physical activity among U.S. young adults, 18 to 30 years of age, from NHANES III. Ann Behav Med 2003;**26:**15–23.

11. Kaplan MS, Newsom JT, McFarland BH, et al. Demographic and psychosocial correlates of physical activity in late life. Am J Prev Med 2001;21**:**306–12.

12. Pitsavos C, Panagiotakos DB, Lentzas Y, et al. Epidemiology of leisure-time physical activity in socio-demographic, lifestyle and psychological characteristics of men and women in Greece: the ATTICA Study. BMC Public Health 2005;5**:**37.

13. Park SY, Murphy SP, Wilkens LR, et al. Dietary patterns using the Food Guide Pyramid groups are associated with sociodemographic and lifestyle factors: the multiethnic cohort study. J Nutr 2005;135**:**843–9.

14. Haenle MM, Brockmann SO, Kron M, et al. Overweight, physical activity, tobacco and alcohol consumption in a cross-sectional random sample of German adults. BMC Public Health 2006;6**:**233.

15. Imhof A, Woodward M, Doering A, et al. Overall alcohol intake, beer, wine, and systemic markers of inflammation in western Europe: results from three MONICA samples (Augsburg, Glasgow, Lille). European Heart Journal 2004;25**:**2092-100.

16. Voorrips LE, Ravelli AC, Dongelmans PC, et al. A physical activity questionnaire for the elderly. Med Sci Sports Exerc 1991;23**:**974–9.

17. WHO: Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser 1995;854**:**427–37.

18. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem. 1972;18:499-502.

19. Saverymuttu SH, Joseph AE, Maxwell JD. Ultrasound scanning in the detection of hepatic fibrosis and Steatosis. Br Med J (Clin Res Ed) 1986;292**:**13-5.

20. Boehm BO, Claudi-Boehm S, Yildirim S, et al. Prevalence of the metabolic syndrome in southwest Germany. Scand J Clin Lab Invest Suppl 2005;240:122–8.

21. Sternfeld B, Ainsworth BE, Quesenberry CP. Physical activity patterns in a diverse population of women. Prev Med 1999;28**:**313–23.

22. Gal DL, Santos AC, Barros H. Leisure-time versus full-day energy expenditure: a cross-sectional study of sedentarism in a Portuguese urban population. BMC Public Health 2005;5**:**16.

23. Martínez-González MA, Varo JJ, Santos JL, et al. Prevalence of physical activity during leisure time in the European Union. Med Sci Sports Exerc 2001;33**:**1142–6.

24. Azevedo MR, Araújo CL, Reichert FF, et al. Gender differences in leisure-time physical activity. Int J Public Health 2007;52:8-15.

25. Jurj AL, Wen W, Gao YT, et al. Patterns and correlates of physical activity: a cross-sectional study in urban Chinese women. BMC Public Health 2007;7**:**213.

26. Chen YJ, Huang YH, Lu FH, et al. The correlates of leisure time physical activity among an adults population from southern Taiwan. BMC Public Health 2011;11:427.

27. Lacour JR, Kostka T, Bonnefoy M. Physical activity to delay the effects of aging on mobility. Presse Med 2002;31:1185–92.

28. Drygas W, Kwasniewska M, Kaleta D, et al. Epidemiology of physical inactivity in Poland: prevalence and determinants in a former communist country in socioeconomic transition. Public health 2009;123:592-7.

29. Aadahl M, Kjaer M, Jørgensen T. Associations between overall physical activity level and cardiovascular risk factors in an adult population. Eur J Epidemiol 2007;22:369-78.

30. Ball K, Owen N, Salmon J, et al. Associations of physical activity with body weight and fat in men and women. Int J Obes Relat Metab Disord 2001;25:914-9.

31. Hu G, Qiao Q, Silventoinen K, et al. Occupational, commuting, and leisure-time physical activity in relation to risk for Type 2 diabetes in middle-aged Finnish men and women. Diabetologia 2003;46**:**322–9.

32. Hu FB, Li TY, Colditz GA, et al. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. JAMA 2003;289:1785-91.
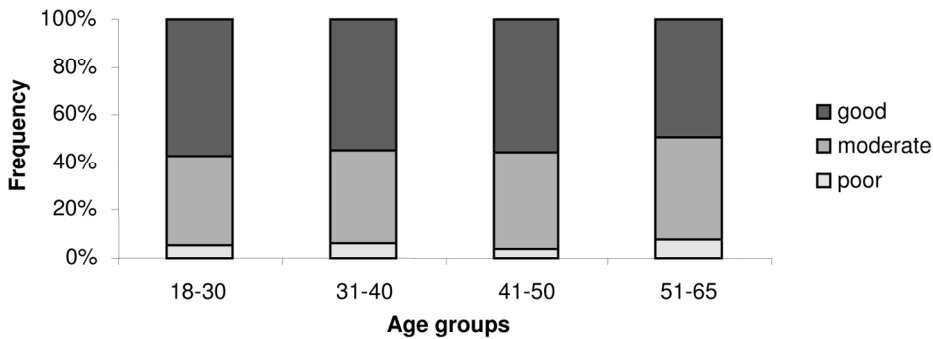
33. Hu FB, Leitzmann MF, Stampfer MJ, et al. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. Arch Intern Med 2001;161:1542-8.

34. Halldin M, Rosell M, de Faire U, et al. The metabolic syndrome: prevalence and association to leisure-time and work-related physical activity in 60-year-old men and women. Nutr Metab Cardiovasc Dis 2007;17**:**349–57.
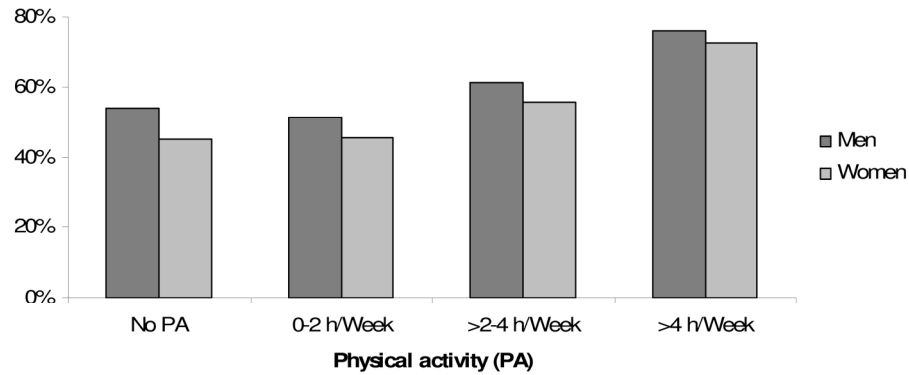
35. Laaksonen DE, Lakka HM, Salonen JT, et al. Low levels of leisure-time physical activity and cardiorespiratory fitness predict development of the metabolic syndrome. Diabetes Care 2002;25**:**1612–18.

36. Rennie KL, McCarthy N, Yazdgerdi S, et al. Association of the metabolic syndrome with both vigorous and moderate physical activity. Int J Epidemiol 2003;32**:**600–6.

37. Mendez-Hernandez P, Flores Y, Siani C, et al. Physical activity and risk of Metabolic Syndrome in an urban Mexican cohort. BMC Public Health 2009;9**:**276.

38. Hsieh SD, Yoshinaga H, Muto T, et al. Regular physical activity and coronary risk factors in Japanese men. Circulation 1998;97**:**661–5.

39. Brownson RC, Eyler AA, King AC, et al. Patterns and correlates of physical activity among US women 40 years and older. Am J Public Health 2000;90**:**264–70.

40. Becker S, Huy C, Brinkhoff KP, et al. "Living an active life"- sports, exercise and health in middle-aged and older adults. An empirical database on physical activity, health behavior and lifestyle in the 50- to 70-year-old residential population of Baden-Wuerttemberg. Gesundheitswesen 2007;69:401–7.

41. Pan SY, Cameron C, Desmeules M, et al. Individual, social, environmental, and physical environmental correlates with physical activity among Canadians: a cross-sectional study. BMC Public Health 2009;9:21.

42. Hagströmer M, Troiano RP, Sjöström M, Berrigan D. Levels and patterns of objectively assessed physical activity--a comparison between Sweden and the United States. Am J Epidemiol. 2010;171:1055-64.

43. Hansen BH, Kolle E, Dyrstad SM, Holme I, Anderssen SA. Accelerometer-determined physical activity in adults and older people. Med Sci Sports Exerc. 2012;44:266-72.

Self assessed physical fitness according to age groups
146x60mm (300 x 300 DPI)

Physical activity in women and men with self-assessed "good" Physical Fitness
175x81mm (300 x 300 DPI)