

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

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## ABSTRACT

**Objectives:** The aim of this study was to investigate the degree of physical exercise and self-assessment of physical fitness (PF) 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 women and 47.9% men.

### 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 PF.

**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 body mass index and 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 and high physical exercise.

**Conclusions:** The 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.

## 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 to an improved quality of life and reduces the risk of a variety of disorders, including

## ARTICLE SUMMARY

### Article focus

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

### Key messages

- Individuals with high educational level are more likely to be physically active.
- Physical exercise is more prevalent in men than in women and is inversely associated with body mass index.
- There is need of promoting physical exercise particularly for special risk groups.

### Strengths and limitations of this study

- 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 standardised interview and not measured quantitatively.

overweight, cardiovascular diseases, diabetes mellitus type 2, stroke and osteoporosis. There is also reduction in both cardiovascular and overall mortality.<sup>1–5</sup> Although the benefits of regular physical activity are widely known, physical exercise remains low in Germany as in most industrialised nations.<sup>6–9</sup> There is a known association of physical exercise with alcohol consumption, non-smoker status and healthy diet.<sup>10–13</sup> 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, alcohol and tobacco consumption, sonographically assessed hepatic steatosis, socio-demographic 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).<sup>14</sup> A total of 4000 of 12475 persons of an urban population were randomly selected from the registry of inhabitants and invited to participate in the study. Of those invited, 2445 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 2173 subjects aged 18–65 years were included in the present analysis.

A more detailed description of subject recruitment has been published elsewhere.<sup>14</sup>

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 (eg, date of birth, gender, education, medical history), health behaviour (eg, exercise) and other risk factors for disease (eg, 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 (eg, alcohol questions from the MONICA Study).<sup>15</sup> 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 Voorrips *et al.*<sup>3 9 16</sup> Participants were asked how many hours per week they spent on physical exercise and sports (0–2, 2–4, 4–10, >10 h). 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 h/week), ‘moderate’ (0–4 h/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 provided by the interviewer. Based on these responses, subjects’ PF was classified as ‘good’ (7–10), ‘moderate’ (4–6) and ‘poor’ (0–3).

### Anthropometry

Based on WHO recommendations,<sup>17</sup> 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/m<sup>2</sup>; normal weight = BMI 18.5 to <25 kg/m<sup>2</sup>; overweight = BMI 25 to <30 kg/m<sup>2</sup>; obesity, grade I = BMI 30 to <35 kg/m<sup>2</sup>; obesity, grade II = BMI 35 to <40 kg/m<sup>2</sup>; obesity, grade III = BMI >40 kg/m<sup>2</sup>.

### 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, Delaware, 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.<sup>18</sup> 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 mmol/l (men) and >1.2 mmol/l (women).

### 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/m<sup>2</sup>, serum triglycerides >1.7 mmol/l, HDL <1.0 mmol/l (men) or <1.2 mmol/l (women), history of arterial hypertension, random blood glucose >8.9 mmol/l and/or history of diabetes mellitus.<sup>19</sup> 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, Washington, USA) with identical settings and a 2–5 MHz probe. Assessment of hepatic steatosis was performed using criteria established by Saverymuttu *et al.*<sup>20</sup>

### Statistics

Absolute and relative frequencies were calculated for qualitative factors in the descriptive statistical analysis, while for quantitative factors, mean and SD, 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 socio-demographic, behaviour-specific and health-relevant factors as well as with subjects’ PF was determined and evaluated using ORs and 95% CI derived from the logistic regression analysis. In order to make representative statements, data were adjusted for gender, age, BMI, educational level, tobacco and alcohol consumption.

The statistical evaluation was performed using the SAS V.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, 95% CI 1.46 to 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 waist-to-hip ratio, there was a negative association with moderate (OR 0.73, 95% CI 0.62 to 0.87) and high (OR 0.64, 95% CI 0.48 to 0.87) physical exercise.

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 g/day (table 2).

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, 95% CI 0.24 to 0.86; table 3).

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' and a further 44% of women and 37% of men 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 OR of high physical exercise level (more than 4 h/week) associated with 'good' PF was 2.6 for men and 3.2 for women (figure 2, table 4).

## 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 programmes.

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=2445), which is comparable to other cross-sectional studies.<sup>21 22</sup>

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.<sup>6 12 23 24</sup> Our study identified age differences in physical exercise. The prevalence of inactivity was the highest in the 51–65-year-old age group. Although most studies in Europe and the USA<sup>11 21 23</sup> report that physical activity declines with age, some studies from Asia show a positive association between physical activity and increasing age.<sup>25 26</sup> This is possibly a result of increased leisure-time physical activity participation after retirement.<sup>26</sup> Older people are at a higher risk for disability and reduction in cardiopulmonary capacity: hence, intervention programmes should focus more on physical activity opportunities for the older

**Table 1** Association of PE 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 to 1.16)	2.05 (1.46 to 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 to 1.36)	0.44 (0.28 to 0.70)*
41–50	180 (37)	257 (53)	50 (10)	1.11 (0.81 to 1.53)	0.59 (0.37 to 0.95)*
51–65	293 (44)	306 (46)	64 (10)	0.96 (0.70 to 1.31)	0.54 (0.34 to 0.86)*
BMI (kg/m <sup>2</sup> )					
Underweight (<18.5)	23 (44)	27 (52)	2 (4)	0.78 (0.43 to 1.42)	0.19 (0.04 to 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 to 1.02)	0.57 (0.40 to 0.82)*
Adipositas (≥30)	198 (53)	149 (40)	27 (7)	0.55 (0.42 to 0.72)*	0.34 (0.21 to 0.55)*

\*p<0.05.

†Adjusted for sex, age, BMI (kg/m<sup>2</sup>), educational level, tobacco smoking and alcohol consumption. BMI, body mass index; PE, physical exercise.

**Table 2** Association of PE 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 to 0.62)*	0.36 (0.08 to 1.57)
CSE equivalent	458 (49)	396 (42)	81 (9)	References	References
GCSE equivalent	203 (33)	338 (54)	80 (13)	1.78 (1.41 to 2.25)*	1.94 (1.32 to 2.85)*
A-levels equivalent	118 (26)	270 (59)	73 (16)	2.35 (1.80 to 3.06)*	2.74 (1.83 to 4.09)*
Smoking					
Current smoker	299 (47)	275 (43)	60 (10)	0.65 (0.51 to 0.82)*	0.45 (0.31 to 0.66)*
Ex-smoker	174 (35)	264 (53)	65 (13)	1.11 (0.86 to 1.43)	0.99 (0.67 to 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 to 1.97)	1.32 (0.60 to 2.93)
No consumption	329 (47)	296 (43)	71 (10)	References	References
0–20 g/day	317 (35)	469 (52)	110 (12)	1.47 (1.18 to 1.85)*	1.40 (0.96 to 2.04)
21–40 g/day	82 (30)	153 (56)	39 (14)	2.00 (1.43 to 2.80)*	1.99 (1.18 to 3.33)*
>40 g/day	55 (37)	74 (50)	18 (12)	1.69 (1.11 to 2.58)*	1.40 (0.72 to 2.72)

\*p&lt;0.05.

†Adjusted for sex, age, body mass index (kg/m<sup>2</sup>), educational level, tobacco smoking and alcohol consumption. PE, physical exercise.

people.<sup>27</sup> Studies of physical activity and leisure-time physical activity in Bavaria confirm the findings of the present study and show that increased physical activity, especially in non-obese women, is associated with a decreased rate of type 2 diabetes mellitus.<sup>3 6</sup>

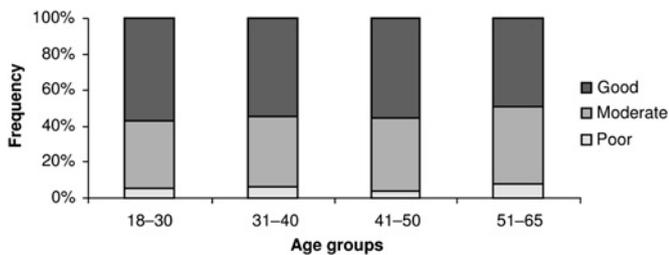
There were also differences in physical exercise in relation to subjects' educational level. By far, the highest degree of physical inactivity was reported in women (93%) and men (63%) who had not completed formal education and declines with increasing educational

**Table 3** Association of PE 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 to 1.13)	1.32 (0.61 to 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 to 1.38)	0.76 (0.41 to 1.39)
Grade II/III	182 (49)	152 (41)	40 (11)	0.76 (0.55 to 1.04)	0.88 (0.53 to 1.45)
Diabetes					
No	789 (39)	1009 (50)	239 (12)	References	References
Yes	33 (57)	16 (28)	9 (16)	0.45 (0.24 to 0.86)*	1.11 (0.48 to 2.60)
Hypertension					
No	654 (37)	878 (50)	215 (12)	References	References
Yes	159 (49)	135 (41)	32 (10)	0.79 (0.59 to 1.05)	0.99 (0.61 to 1.62)
HDL					
Normal	656 (38)	864 (50)	210 (12)	References	References
Reduced	140 (48)	121 (41)	31 (11)	0.88 (0.66 to 1.17)	0.92 (0.57 to 1.48)
LDL					
Normal	561 (39)	689 (48)	173 (12)	References	References
Elevated	137 (42)	157 (48)	31 (10)	1.01 (0.77 to 1.33)	0.76 (0.48 to 1.21)
Triglyceride					
Normal	500 (38)	663 (50)	156 (12)	References	References
Elevated	264 (45)	257 (44)	69 (12)	0.83 (0.66 to 1.05)	0.96 (0.66 to 1.41)
Cholesterolin					
Normal	306 (39)	369 (47)	105 (14)	References	References
Elevated	511 (39)	644 (50)	141 (11)	1.11 (0.90 to 1.38)	1.04 (0.74 to 1.47)

\*p&lt;0.05.

†Adjusted for sex, age, body mass index (kg/m<sup>2</sup>), educational level, smoking and alcohol consumption. HDL, high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol; PE, physical exercise.



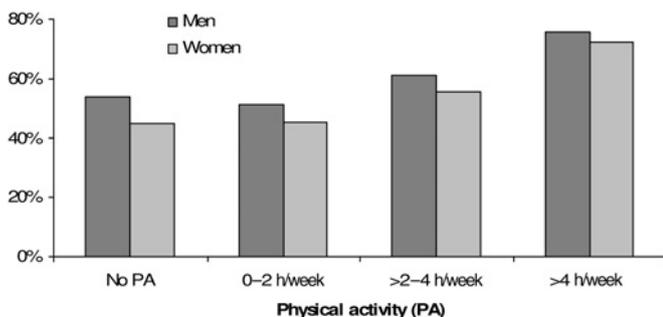
**Figure 1** Self-assessed physical fitness according to age groups.

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.<sup>3 25 28</sup> 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.<sup>29 30</sup>

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.<sup>3 31-33</sup> However, we did not show an association between metabolic syndrome and physical exercise. Halldin *et al*<sup>34</sup> 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.<sup>35-37</sup> Unlike results published by Hsieh *et al*,<sup>38</sup> 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.

In agreement with other studies, our findings showed that male and female smokers were significantly less physically active than were non-smokers.<sup>3 39</sup> Participants reporting consumption of moderate amounts of alcohol were more physically active than those reporting no



**Figure 2** Physical activity in women and men with self-assessed 'good' physical fitness.

**Table 4** Association of physical exercise with self-assessed 'good' physical fitness

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

\*p<0.05.

†Adjusted for age.

alcohol consumption. A similar observation was reported for the MONICA/KORA Study in which persons with moderate alcohol consumption patterns tended towards a higher activity level than did non-drinkers.<sup>3</sup> 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 PF, findings were very similar with regard to physical activity. Becker *et al*<sup>40</sup> showed that persons with poor subjective assessment of general health were under-represented in the physically active group. Pan *et al*<sup>41</sup> reinforced this result when considering both sexes together. 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*,<sup>7</sup> 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, 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 standardised interview and not

measured quantitatively. Self-reported data may result in overestimation, especially in the assessment of physical exercise.<sup>6</sup> Objective methods such as accelerometers, pedometers or heart rate monitoring are more precise than subjective assessment.<sup>42–43</sup> 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.

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**Competing interests** None.

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**Data sharing statement** There is no additional data available.

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