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Master Thesis

Master of Public Health (MPH)

Physical Activity and Quality of Life in Individuals with and without Diabetes Mellitus

Results of the German National Health and Examination Survey

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[redacted]

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Eidesstattliche Erklärung / Statutory declaration

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This is to declare that I have prepared following thesis entirely by myself using only the sources mentioned. This thesis – or any variation thereof - has never been submitted to any examination authority.

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(Anke Hanssen-Doose)

Hamburg, 31.August 2004 / Hamburg, 31st of August 2004

Background of this Master Thesis

The following Master Thesis is to be submitted for publication to The European Journal of Public Health (EJPH), a quarterly journal for scientific articles within the area of public health. Structure and formal style of the manuscript is derived from the author's information at the EJPH website (www3.oup.co.uk/eurpub).

Abstract

Background

Physical activity is important in preventing and managing type-2 diabetes. Physical inactivity is globally one of the biggest public health hazards. The aim of this study was to assess the physical activity of individuals with diabetes using a German representative population sample.

Methods

Subgroups of 248 individuals with diabetes and 3450 controls without diabetes were identified from a larger representative sample, the German National Health and Examination Survey. The subgroup of the cross-sectional study was 40 to 70 years old. The participants completed a questionnaire and underwent a physical examination.

Results

Most of the individuals with diabetes (between 84% and 92%) did not meet the recommended standard of 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week. 67% reported no sports activities in the past three months. Of the controls, 78% - 84% did not attain a sufficient physical activity level, 49% reported no sports in the last three months. Compared to the controls without diabetes, the individuals with diabetes had a significantly lower quality of life (SF-36). After controlling for sociodemographic variables and quality of life, diabetes was associated with physical inactivity.

Conclusions

In Germany, the current physical activity levels are alarming low! In individuals with diabetes, the risk of being inactive is even higher, what causes an increased risk of getting diabetes-specific complications. Public health action is needed to get out of this vicious cycle.

Key Words: Diabetes, Physical Activity, Exercise, Quality of Life

Physical Activity and Quality of Life in Individuals with and without Diabetes Mellitus

Introduction

Physical activity is important in preventing and managing type-2 diabetes. The lack of physical activity in the general public is globally one of the most important public health problems. The aim of this paper was to assess the physical activity of individuals which already have diabetes using a large epidemiological sample from the German National Health Interview and Examination Survey (GNHIES).

Type-2 diabetes is characterized by insulin resistance and relative insulin deficiency, it is increasingly common worldwide. This chronic metabolic disorder is associated with many severe complications such as premature death from cardiovascular disease, preventable blindness, non-traumatic amputations and end-stage renal disease. On the basis of estimates, 194 million people have diabetes worldwide and at least 6 Million Germans, 90% to 95% of them type-2 diabetes.[1,2] Published results from the German National Health and Examination Survey 1998 established the prevalence rate of diabetes mellitus as 5% for men and as 6% for women.[3] The prevalence rate is strongly increasing with age.

Besides appropriate nutrition, regular and adequate physical activity is the universal remedy in the sense of primary and secondary prevention. [4,5,6] The epidemiological research supports an association between physical inactivity and type-2 diabetes.[7]

Regular physical activity is seen as useful measure in preventing, delaying the onset and treating type-2 diabetes.[8,9,10,11,12,13,14] It directly increases insulin-mediated glucose disposal and therefore improves insulin resistance.[15] The role of physical activity in primary and secondary prevention is accepted by the scientific community as well as by the general public. Nevertheless, the major part of the German society remains physically inactive.[16,17,18] This phenomenon is globally noticeable and it emphasises the relevance of physical inactivity as a major public health hazard. The World Health Report published in 2002 by the World Health Organisation (WHO), demonstrated physical inactivity as a major health determinant of the "global pandemic of avoidable chronic diseases".[19] To reduce the health burden of physical inactivity, the US Center for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) developed recommendations as public health messages. The most recent recommendation is: Every individual should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week.[20] This recommendation is also supported by German public health experts from the Robert Koch Institute.[21] The adoption of a physically more active lifestyle may lead to "enhanced quality of life".[20] "Quality of life" has been recognized as an important health outcome. Being understood as a multidimensional construct, the quality of life incorporates social, psychological and physical health. Brown et al.[22] found out that persons achieving the recommended physical activity levels were more likely to report a better health-related quality of life. Besides analysing the present physical activity levels of individuals with diabetes, another objective of this study was describing the relationship between the physical activity and the quality of life.

Research Design, Material and Methods

The population of the present study was derived from the German National Health Interview and Examination Survey (GNHIES), which is a nationally representative sample of noninstitutionalised German adults (18–79 years). The study was carried out as a cross-sectional study. Between October 1997 and March 1999, 7,124 persons (3,674 women, 3,450 men) from official registries were surveyed regarding various past and present diseases and other health-related topics. A detailed description of the design and random sampling procedures are available elsewhere.[23,24,25] The response rate of the main survey was 61,5% (7,124 out of 11,601 addressed individuals). The individuals completed a questionnaire (Public Use File BGS98) and underwent a physical examination conducted by a physician in which anthropometrical, physiological and disease specific data were collected.

Study population

The present study included all individuals of the parent population (7,124 individuals) aged between 40 and 70 years with or without the condition diabetes mellitus (N=3,698). Individuals who reported an unknown diabetes status were excluded from the analysis (n=34)

Diabetes Mellitus

Diabetes mellitus was considered to be present if the participant due to the self-administered questionnaire has ever been diagnosed to have diabetes mellitus (insulin-dependent or non-insulin-dependent). In the physician's interview afterwards more information about the disease was collected. The respondents did not have to

classify whether they had type-1 or type-2 diabetes. A blood sample had been taken to determine the laboratory parameter. The glycosylated haemoglobin A1C (HbA1C) values were collected during the laboratory exam by means of the DIAMAT system (company BIORAD) RECIPE-ClinRep with the reference interval from 4.3% to 6.1% considered normal.

Physical Activity

The Physical Activity was measured by means of four questions (question 61 to 64 of the main survey's 107 questions) with the reference period of "During the last three months" or "usually". Question 61: The duration of sport activities in hours per week (five categories 1st regularly, more than 4 hours per week, 2nd regularly, between two and four hours per week, 3rd regularly, between one and two hours per week, 4th less than one hour per week, 5th no sports). Question 62: A 24-hours activity protocol – the distribution of different levels of activities during the whole day in hours. The participants had to calculate how much time they spent on sleeping, sitting, participating in light, moderate and vigorous activities each day so that they ended up with 24 hours in total. There were examples for each category available. Question 63: The frequency of leisure time activities that lead to light perspiration or being out of breath (five time variables from "never" to "everyday" and four categories "less than 10 min", "10 to 20 min", "20 to 30 min" and "30 min and more"). Additionally, in the component of the GNHIES about utilisation of medical services available in Germany under statutory sickness insurance facilities, there was information available, whether the individuals received physician-based physical activity counselling or not and if this influenced their physical activity patterns or not.

Quality of Life

The SF-36 Questionnaire [26] was used to assess the health-related quality of life from individual's perspective. It consists of 36 questions related to eight subscales: The scores of each subscale run from 0 – 100. A higher score denotes a more positive functioning or aspect of health.

Statistical analysis

All statistical analysis was performed using SPSS 12.0. Differences between the groups were calculated by independent-group Student's *t* test and x^2test. Statistical significance was considered present if the double-sided p-value was less than 0.05. The classification of the study participants into social classes has been defined with the help of the Winkler-Score[27], taking into account the highest school degree, professional training, net-income of the household, job position, job position of the partner and whether the respondent is the chief earner of the household. There were two variables in the outcome: a descriptive three class model and a quantitative score from 3 to 21. To assess the associations between diabetes and physical activity, logistic regression was used. The complex sampling design was not taken into account because this procedure was unavailable in SPSS 12.0.

Results

The characteristics of the study groups are shown in Table 1.

Table 1 Characteristics of the sample

Variables	Individuals with diabetes (n=248)	Controls without diabetes (n=3450)
Age [years]	59±7 SD [58-60 CI]	54±9 SD [52-53 CI]
BMI [kg/m²]	30±6 SD [29-30 CI]	28±5 SD [27-28 CI]
Female Sex	107 (43%)	1798 (52%)
Marital Status		
Married	198 (80%)	2727 (79%)
Divorced/widowed/separated	38 (15%)	521 (15%)
Single	11 (4%)	185 (5%)
School Education		
Low [0-9 years]	165 (67%)	1716 (49%)
Middle [10-11 years]	51 (21%)	1016 (29%)
High [≥ 12 years]	25 (10%)	642 (19%)
Others	6 (2%)	51 (2%)
Social class [scores 3-21]	10±4 SD [10-11 CI]	12±4 SD [12-12 CI]
Low	92 (37%)	700 (20%)
Middle	118 (48%)	1832 (53%)
High	34 (14%)	881 (26%)
Without work	20 (8%)	274 (8%)

Data are either mean ± standard deviation with 95% confidence interval or absolute numbers and %. The missing per cent to 100% are due to missing values.

The sample included 248 individuals with diabetes (ID) and 3450 controls without diabetes (CO). Table 1 illustrates the characteristics of both groups: the individuals with diabetes (ID) were older (p=0.000), lower educated, had a lower social status (p=0.000) and a higher BMI (p=0.000) than the controls without diabetes (CO). The mean duration of the disease diabetes mellitus was 8.3 years±7.4 (SD). Of the individuals with diabetes (ID), n=163 (55%) had no diabetes-related complication. Among the ID with diabetes-related complications, the following complications were detected n=39 with diabetic eye disease, n=10 with diabetic renal disease, n=29 with diabetic neuropathy, n=8 with a diabetic foot, n=12 with cardiovascular complications, n=10 with tendency for infections, n=15 with sexual dysfunction, n=7 with non-traumatic amputations and one other complication. The mean glycosylated haemoglobin A1C (HbA1C) of the individuals with diabetes, who do not have diabetes-specific complications was 7.4% ±1,6 (95% CI 7.1-7.7), for those with complications the mean HbA1C was 8.2% ±1.6 SD (95% CI 7.8-8.6). In table 2, the physical activity results are described.

Table 2 Results Physical Activity

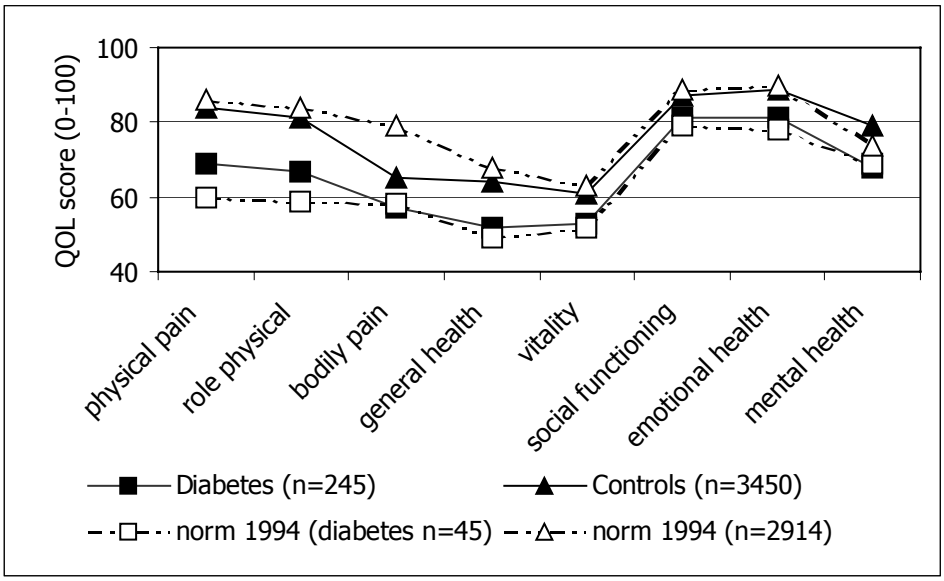
Variables	Individuals with diabetes (ID)		Controls without diabetes (CO)	
Sport activities				
No sport	167	(67%)	1690	(49%)
Less than 1h/week	35	(14%)	534	(16%)
Between 1h and 2h/week	26	(11%)	642	(19%)
Between 2h and 4h/week	12	(5%)	371	(11%)
More than 4 h/week	7	(3%)	184	(5%)
24-h Activity Protocol (h/week)				
Light Physical Activity	37 h±19 SD [34-39 CI]		36 h±18 SD [35-36 CI]	
Moderate Physical Activity	15 h±13 SD [13-16 CI]		19 h±15 SD [19-20 CI]	
Vigorous Physical Activity	8 h±13 SD [7-10 CI]		9 h±13 SD [9-10 CI]	
Leisure Time Activity per week that leads to perspiration (minutes)	29±60 SD [22-37 CI]		32±55 SD [30-34 CI]	

Data are either mean ± standard deviation with 95% confidence interval or absolute numbers and %. The missing per cent to 100% are due to missing values.

The prevalence of sports activities was lower in the individuals with diabetes compared to the controls. In the 24-h-Activity Protocol, the individuals with diabetes were equally engaged in light physical activities (p=0.597), significantly lower engaged in moderate activities (p=0.000) and equally engaged in vigorous activities (p=0.277). There was no significant difference between the weekly leisure time activity, which leads to light perspiration or being out of breath. Physician-based physical activity counselling was received by 9% of the individuals with diabetes (n=22) and also by 9% of the controls (n=309). 17 out these 22 individuals with

diabetes changed their physical activity patterns afterwards (77%); so 166 out of 309 controls (54%) did. The results of the quality of life (SF-36) are illustrated in the next figure:

Figure 1: Results Quality of Life (present results and 1994 norms)



There were significant differences in the quality of life between the individuals with diabetes compared to the controls without diabetes in all subscales (p-values p=0.000).

The recommended minimal standard of physical activity is 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week. Table 3 presents the absolute numbers of participants who (not) attained the recommended physical activity level operationalised as sports activities.

Table 3 Diabetes and Sports Activities

	Individuals with Diabetes	Controls without Diabetes	
Less than minimal standard of physical activity (sports)	228	2866	3094
More than minimal standard of physical activity (sports)	19	555	574
	247	3421	3668

(data are absolute numbers, n=30 values are missing)

Only 8% of the individuals with diabetes met the recommended standard of physical activity and 16% of the controls without diabetes. The prevalence of the exposure "not meeting the recommended physical activity levels" is 2.2 times higher in individuals with diabetes than in the controls without diabetes (RR 95% CI 1.4-3.5). The relative risk (RR) does not significantly differ between the sexes with RR men being 2.3 (95% CI 1.3-4.2) and RR women being 2.2 (95% CI 1.1 – 4.7). The prevalence of insufficient physical activity levels was in the age group 40 – 49 and 50 to 59 not significantly higher in the individuals with diabetes compared to the controls (age group 40 to 49: R 1.7 95% CI 0.5-5.9 and age group 50 to 59: RR 1.9 95% CI 0.8-4.4). Only in the age group 60-70 the RR of not meeting the recommended physical activity level was significantly higher with RR being 2.1 (95% CI 1.6-3.9).

The results with physical activity operationalised as sports or moderate to vigorous leisure time activity without interruptions:

Table 4 Diabetes and Physical Activitiy

	Individuals with Diabetes	Controls without Diabetes	
Less than minimal standard of physical activity	208	2683	2891
More than minimal standard of physical	39	740	779
	247	3423	3670

(data are absolute numbers, n=28 values are missing)

With this classification, 16% of the individuals with diabetes and 22% of the controls without diabetes met the recommended minimal standard of physical activity. The prevalence of exposure "not meet the recommended minimal standard of physical activity" measured as sport activities or leisure time activity is higher in individuals with diabetes (RR 1.4 95% CI 1.0-2.0). Stratified by age, the individuals with diabetes (ID) showed no significantly higher RR (age group 40 – 49: RR 0.7 [95% CI 0.3-1.7], age group 50 to 59: RR 2.2 [95% CI 1.0-4.6] and age group 60-70: RR 1.3 [95% CI 0.9-2.2]).

The first logistic regression model was based on a binary dependent variable ("diabetes" / "no diabetes") aside from the physical activity variables and the quality of life scores as independent variables. The model was adjusted for age, sex, BMI and social class. It failed due to insufficient goodness of fit (Hosmer-Lemeshow test)

and model statistics (Nagelkerkes R^2). The first model predicted only 1% of the individuals with diabetes. Possible causes may be insufficient model specification, multicollinearity or disproportionality of the groups. A subdivision of diabetes by means of the HbA1c values or the presence or absence of complications were also not an option for a better regression model. Through an additional exploratory discriminant function analysis, the strongest variables were detected which distinguish best between the individuals with diabetes and the controls without diabetes (except for the HbA1c values and disease specific information). The predictors for diabetes as criterion were: physical functioning (SF-36), social class, age, BMI, sex, vitality (SF-36) and bodily pain (SF-36). After crossvalidation 72% have been classified correctly. These variables were additionally entered into the logistical regression model besides the already existing variables. In order to come to terms with the disproportionality difficulties, the cut-off for classification was shifted from 0.50 to 0.40. The adjusted Odds Ratios were calculated by a direct, backward stepwise binary logistical regression.

Associations between diabetes and physical activity adjusted for socio demographic factors and other relevant confounder.

Table 5 Associations between diabetes, physical activity and sociodemographic variables

Variables	Odds Ratios Diabetes/Controls	95% CI
Hours of daily moderate activities	0.983 OR	[0.963-0.999]
HbA1c	3.715 OR	[3.032-4.550]
Vitality (SF-36)	0.979 OR	[0.969-0.989]
Age	1.056 OR	[1.028-1.084]
Social class	0.945 OR	[0.892-1.002]
BMI	1.027 OR	[0.990-1.066]

Reference category: Controls without diabetes

The fit of the regression model was examined with the Hosmer-Lemeshow test. Of the individuals with diabetes, 44% and of the controls 99% were predicted correctly by this model. Nagelkerkes R^2 improved strongly and reached 0.435.

Discussion

In all probability, this is the first study to examine the physical activity and the quality of life in individuals with diabetes on population level in Germany. The design was cross-sectional, making determinants of cause and effect and temporal relationships impossible. So the question was not, whether diabetes mellitus had been preventable by increased physical activity, the question was, what physical activity and quality of life was like when individuals already suffered from the

disease. It is alarming that neither the individuals with type-2 diabetes, nor their controls without met the recommended minimal standard of physical activity and that the physical activity patterns of the individuals with diabetes were even worse. Between 84% and 92% of the individuals with diabetes and between 78% to 84% of the controls were not sufficiently physically active. These proportions are corresponding to findings by the U.S. Department of Health and Human Services [4], in which 60% - 80% percent of the U.S. adults were not physically active enough. Correlating with studies mostly in the U.S., the findings of the present study are also in relation to the physical activity in individuals with diabetes that can be described as even less physically active than the general public.[28,29,30] The individuals with diabetes in the present study had a quality of life level below the controls without diabetes - various authors reported similar findings.[31,32] Brown [22] found out, that having diabetes is independently associated with lower quality of life. Perhaps the physical activity improves the quality of life or perhaps people with low quality of life are less likely to be engaged in physical activity. There is a third possibility: an overlap of the concepts physical activity and quality of life to a great extent. A more holistic understanding of the nature of physical activity could serve as a basis a fully understanding of its influences on quality of life.[33] In planning physical activity interventions it must be taken into account that many individuals with diabetes have low quality of life levels, especially in vitality, physical functioning and bodily pain.

The main limitations of the study can be found in the potential biases due to self reported physical activity data. Knowing the fact, that in Germany there is no representative physical activity surveillance system, that is more frequent and more

detailed than the GNHIES, the choice of the study as foundation for this particular research question was the best available. The GNHIES is not primarily concerned with the assessment of physical activity. The relevant physical activity questions were in the order of the questionnaire number 61 to 64 out of 107 mainly complex questions of the main survey. Mensink [17] refers to the limitations of the physical activity components as being one topic among many other health-related topics of the GNHIES. This is at the expense of thoroughness in relation to the purposes and contexts of physical activities (leisure time, job, sports, transport, etc.) and detailed descriptions of the activities. It is possible that the results are biased due to limitations of the respondent's concentration. The question 61 has been targeting towards the duration of sports activities. There remains an interpretation space in the German word "sport": especially older individuals understand sports activities in the sense of competitive or organised sport, whereas for younger respondents the term includes also nonorganised sport and leisure time activities. To control this possible bias regarding the classification, sports activities alone and in combination with leisure time activities which lead to light perspiration were measured. The results in question 62, the 24h-activity protocol take the turn of the physical activity results for the better. These results should not be overrated since methodological difficulties entered, which probably threatened the validity of this question at least in the category "vigorous intensity activity". In calculating the activity durations per week some respondents miscalculated so that the total was not 24 hours (total in the week: mean 24, min 5, max 29, SD 0.6 and total at the weekend: mean 24, min 6, max 35, SD 0.8). So "vigorous intensity activity" as last category has maybe "generously" been filled up by some respondents to end up with 24 hours. To sum

up the difficulties with the questions 62 and 63, the potential bias would affect individuals with or without diabetes equally, but perhaps a simplification of the question's structure and the assessment of activity purposes would help to be more precise in the assessment of the strength of relationships between physical activity and possibly related diseases and dose-response patterns. Another limitation of the present study is the small prevalence rate of the individuals with diabetes compared to relatively many controls without diabetes. Some of the controls had undetected diabetes and pre-diabetes (impaired glucose tolerance), what might have had an influence on the results, but it is very likely that there were not many misclassifications in the diabetes group due to the physician's interviews. There was no clear classification of typ-1 and type-2 diabetes possible therefore the results where not specific for the diabetes types. It is possible that the results differ between the types of diabetes.

The results of this study show that physicians have a strong influence on the physical activity patterns in individuals with diabetes. They have derived much benefit from it, therefore it must be judged as being sub-optimal, that only 9% of the individuals received information and advice in relation to physical activity. In comparing it to the numbers of controls who received physical activity counselling, recall bias must be taken into account. Pearte et al.[34] found out, that the perception of needing to get enough exercise to keep healthy is a predictor for a higher physical activity. The creation of individually feasible steps towards a physically more active lifestyle is a major goal in prevention and treatment of type-2 diabetes. The way to increased physical activity patterns is a movement through different stages. Many try to

become more active but soon relapse back to their sedentary lifestyle. Public health programs and community health programs therefore must offer staged interventions which can be easily adopted by the individuals with diabetes. It is known, that low- to moderate-intensity physical activities are more likely to be continued than high-intensity physical activities.[35] Individuals with diabetes have additional barriers to get physically active and they need more preparation to get an exercise programme started than the general public.[36] Apart from exercise programs, there are many easy options to be more physically active in daily living. The results of this study show that the amount of moderate intensity activities play a key role in classifying individuals with diabetes from those without diabetes. In relation to moderate intensity daily activities besides leisure time activities, Hu [10] reported the role of transport - "active commuting" - as being important which reduced the total and CVD mortality among patients with type-2 diabetes. Active commuting is walking or cycling during all or part of the journey to work, school or appointments.

Despite all limitations of this study, it can not escape someone's notice, that the current physical activity levels are alarming low! In individuals with diabetes, the risk of being physically inactive is even higher. The implication of the sedentary lifestyle on health and quality of life justify to make the elevation of the physical activity levels to an issue of special importance. An effective physical activity monitoring must be available to continuously track the progress towards public health goals like the Behaviour Risk Factor Surveillance System (BRFSS) does is for U.S. citizens or the European Physical Activity Surveillance system as a project for inhabitants of

some member countries of the European Union. Only by public health action, taking all available evidence in account, it is possible to get out of this vicious cycle.

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