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Physical activity and other selected determinants of the body mass index (BMI) in women aged 40–65 with type 2 diabetes from the Krakow population

Maria Gacek
Department of Sports Medicine and Human Nutrition, University of Physical Education in Krakow, Poland, maria.gacek@awf.krakow.pl

Agnieszka Wojtowicz
Department of Psychology, University of Physical Education in Krakow, Poland

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Physical activity and other selected determinants of the body mass index (BMI) in women aged 40–65 with type 2 diabetes from the Krakow population

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B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Maria Gacek[1 ABDEF], **Agnieszka Wojtowicz**[2 CDEF]

[1] Department of Sports Medicine and Human Nutrition, University of Physical Education in Krakow, Poland

[2] Department of Psychology, University of Physical Education in Krakow, Poland

abstract

Background: Excessive body mass is a key risk factor of type 2 diabetes. The aim of the study was to analyse selected determinants of the BMI (body mass index) in women aged 40–65 with type 2 diabetes from the Krakow population. The predictive model includes demographic (age), health (duration of diabetes) as well as behavioural (volume of physical activity) and psychological (life satisfaction) data.

Material and methods: The study was conducted among a group of 276 women aged 40–65 (47.92±5.53) with type 2 diabetes. The authors used a specially designed questionnaire, which included socio-demographic questions as well as self-assessment of the health status, the duration of diabetes and the volume of recreational physical activity per week. The standardised Satisfaction with Life Scale (SWLS), originally by E. Diener, R.A. Emmons, R.J. Larsen and S. Griffin, and adapted by Z. Juczyński, was used. The BMI value of women was assessed based on measurements of somatic indicators (body mass and height) using standard measuring tools (Tanita 300-P and an altimeter). Statistical analysis was performed using Pearson's r correlation coefficient, hierarchical regression and moderation analysis using the SPSS programme, assuming the statistical significance level of $\alpha=0.05$.

Results: The mean BMI for women aged 40–65 with type 2 diabetes was 26.71 (±4.14) kg/m2. Correlation analysis showed an increase in BMI along with age and disease duration, and a decrease along with an increase in the women's life satisfaction. Detailed analysis of the interactional impact of variables on the BMI confirmed the increase in BMI along with duration of the disease, and with the low level of life satisfaction and low and average volume of physical activity (especially in women with low levels of life satisfaction). A decrease in BMI was noted along with an increase in the volume of weekly physical activity (regardless of age).

Conclusions: The values of the index in women aged 40–65 with type 2 diabetes seem to demonstrate significant correlations with age, duration of the disease, volume of physical activity and level of life satisfaction, with an indication of the interactive and moderating influence of some variables.

Key words: type 2 diabetes, BMI determinants, women, life satisfaction, physical activity.

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Corresponding author: Corresponding author: Dr hab. Maria Gacek, Department of Sports Medicine and Human Nutrition, University of Physical Education in Krakow, Al. Jana Pawła II 78, 31-571 Krakow, Poland; Phone: 12 683 11 45, e-mail: maria.gacek@awf.krakow.pl

INTRODUCTION

Non-insulin-dependent diabetes mellitus (T2DM) is a significant public health problem. In the complex aetiopathogenesis of T2DM, a key role, in addition to genetic factors, is played by behavioural conditions, including improper diet (among others, excessive energy supply) and low levels of physical activity, increasing the risk of developing excessive body mass and its metabolic complications [1–8]. The development of obesity and T2DM may also be associated with chronic, autoimmune inflammatory processes induced by glucotoxicity and lipotoxicity [9]. Epidemiological studies have confirmed very strong relationships between obesity, the insulin resistance of tissues and T2DM [3]. Elevated BMI in diabetic patients generates a high risk of diabetes complications, including cardiovascular, cerebral vessel, kidney and lower limb diseases, which has been confirmed among elderly people in the USA [10]. Epidemiological research has proved that the group at an increased risk of degenerative diseases, including the metabolic ones, also includes women at a menopausal age [11]. At the same time, research has confirmed that in women, diabetes complications develop at lower excess values of the BMI than in men [10].

The importance of an increased body mass index (BMI) as one of the basic easily measurable indicators of the nutritional status, indicating overweight or obesity, which increase the risk of developing type 2 diabetes, became the premise for undertaking research on selected determinants of BMI values in women diagnosed with type 2 diabetes mellitus (T2DM). Among the determinants of BMI, in addition to age, illness duration and volume of physical activity, the level of life satisfaction was also taken into account as an indicator of the quality of a patient's life. This is important within the context of the disease's chronic nature and other concomitant diseases significantly reducing patients' quality of life [12].

Previous studies on the determinants of the BMI value and the effectiveness of glycaemic control in people with diabetes indicated, among others, genetic and ethnic predispositions [13], socio-economic factors [14, 15], the level of physical activity [16, 17], the quality of food choices [17, 18] as well as psychological factors [14, 15, 17].

Within this context, research was undertaken with the aim to analyse selected determinants of BMI in women aged 40–65 with type 2 diabetes from the Krakow population. The predictive model includes demographic (age), health (duration of diabetes), as well as behavioural (volume of physical activity) and psychological (life satisfaction) data.

MATERIAL AND METHODS

The study was conducted among a group of 276 women with diagnosed type 2 diabetes, aged 40–65 (47.92 ±5.53) from the Krakow population.

In the study, an original questionnaire created by the author was used with questions concerning 7 areas: a) socio-demographic characteristics (sex, age, place of residence); b) self-evaluation of health (four-level scale of responses: very good, good, average, bad); c) coexistence of other chronic diseases (obesity, hypertension, hyperlipidaemia, coronary heart disease, hypothyroidism, osteoporosis, others; any number of indications); d) how to control glycaemia (insulin or hypoglycaemic agents); e) compliance with medical recommendations

(four-level scale of answers: definitely yes, rather yes, rather not, definitely not); f) the duration of diabetes (the time that has elapsed since the diagnosis of the disease); and g) the volume of recreational physical activity during the week (the number of hours spent on physical activity during free-time per week). The author's questionnaire was submitted to the validation procedure (re-test in a group of 40 people after 6 weeks). The validation procedure, using the Chi^2 McNemar test and the Phi (Youle) coefficient, showed high reproducibility of the results.

In the study, the standardised Satisfaction with Life Scale (SWLS), originally created by E. Diener, R.A. Emmons, R.J. Larsen and S. Griffin, and later adapted by Z. Juczyński [19], was also used. The SWLS scale, containing 5 statements with a seven-point scale of responses (1 – "I totally disagree", 7 – "I completely agree"), is constructed in such a way that the higher the test result (within the range of 5–35 points), the higher the sense of satisfaction with life. The reliability of the scale is 0.81.

The women's BMI value was assessed on the basis of somatic indicator measurements (body mass and height) using standard measuring tools (a Tanita TBF-300P electronic scale and an anthropometric altimeter). Anthropometric measurements were performed in the morning (on an empty stomach). The research was carried out taking the standards of the 1975 Declaration of Helsinki into account, after obtaining informed consent from the examined women.

The inclusion criteria for the group comprised, in particular: female gender, diagnosed type 2 diabetes for a minimum of one year, age 40–65 years (perimenopausal age) and permanent residence in Kraków. Among the exclusion criteria, in addition to gender non-conformity, age, place of residence and type of diabetes, cancer comorbidity was also included (as potentially affecting the body mass index, without a direct relationship to type 2 diabetes). The professional activity (and/or extra after-work activity) was not related to increased physical effort among any of the surveyed women.

Among the factors explaining the BMI value among women with type 2 diabetes, selected variables from various areas of health determinants (and its indicators) were included, containing: age (demographic factor), duration of diabetes (illness duration, health factor), volume of recreational activity physical (behavioural factor associated with lifestyle) and the level of life satisfaction (psychological factor). The factors taken into account were part of the holistic definition of health and its determinants.

Women with diabetes declared co-occurrence of other chronic diseases, including: hyperlipidaemia (56.5%), hypertension (46.0%), obesity (53.3%), hypothyroidism (21.7%), coronary heart disease (6.2%) and osteoporosis (5.1%). They rated their health as average (49.3%) and good (44.9%), rarely as very good (2.5%) or poor (3.3%). Women mostly took oral hypoglycaemic drugs (79.3%) to regulate blood glucose level, and less often, insulin. 25.1% of the surveyed women declared strict adherence to medical recommendations.

Data distribution in terms of demographic and somatic characteristics as well as other variables included in the model of factors explaining the BMI level of women with type 2 diabetes is presented in Table 1. Statistical analysis was performed using Pearson's r correlation coefficient, hierarchical regression and moderation analysis with the SPSS programme, assuming a statistical significance level of $\alpha = 0.05$.

Table 1. Characteristics of the study group in terms of demographic and somatic features, duration of disease, volume of physical activity, and the level of life satisfaction (descriptive statistics)

Variables	Descriptive statistics			
	Minimum	Maximum	M	SD
Age (years)	40.00	65.00	47.92	5.52
Body mass (kg)	59.00	120.00	75.84	13.63
Body height (cm)	154.00	190.00	168.33	8.43
BMI (kg/m^2)	21.00	44.07	26.71	4.14
Satisfaction with Life Scale (SWLS)	10.00	30.00	20.78	5.31
Duration of diabetes (years)	1.00	23.00	7.45	4.92
Volume of physical activity per week (h)	0.00	10.00	2.30	2.31

M – arithmetic mean, SD – standard deviation

RESULTS

Correlation analysis showed that along with the surveyed women's age, there was an increase in BMI, duration of diabetes and the level of life satisfaction. A positive correlation was also noted between the duration of the disease and BMI. In addition, along with the increase in BMI and the duration of diabetes, the level of life satisfaction of the examined women decreased ($p < 0.01$) (Table 2).

Table 2. Correlations between the analysed variables (Pearson's r correlation coefficient)

Variables	Age	BMI	Duration of diabetes	SWLS	Physical activity
Age	1	0.327**	0.372**	0.159**	0.071ns
BMI		1	0.239**	-0.235**	-0.192
Duration of diabetes			1	-0.220**	-0.032ns
Satisfaction with Life Scale (SWLS)				1	0.327**
Physical activity					1

** Correlation assumed significant at the level of $p<0.01$ (both sides); ns – statistically non-significant correlations

Hierarchical regression analysis showed that, apart from age and level of life satisfaction, the interaction of diabetes duration with the level of life satisfaction and physical activity, and also of age with the volume of recreational physical activity, were also significant predicators (Table 3).

Table 3. Hierarchical regression – dependent variable: BMI

Step	Model	β (Step 1)	β (Step 2)	β (Step 3)
1	Age	0.327**	0.355**	0.330**
2	Duration of diabetes		0.051ns	0.083 ns
3	Physical activity		-0.139*	-0.019 ns
4	Satisfaction with Life Scale (SWLS)		-0.235**	-0.164**
5	Interaction: Phys. activ. × Duration of diabetes			-0.197*
6	Interaction: Age × Physical activity			0.171*
7	Interaction: SWLS × Duration of diabetes			-0.416**
	Interaction: SWLS × Physical activity			0.037 ns
	Interaction: Age × SWLS			0.133 ns
R^2		0.107	0.210	0.403
R^2 change		0.107**	0.103**	0.193**
F		32.080**	18.044**	19.965**

** Significant correlations at the level of $p<0.01$; ns – statistically non-significant correlations

Below are the detailed results of interactions between variables: duration of disease and life satisfaction, volume of recreational physical activity and BMI of women with type 2 diabetes. It was found that life satisfaction is an important moderator of the relationship between the BMI level and the duration of diabetes. At low and average levels of life satisfaction, the longer the duration of the disease, the higher the BMI, which was clearly visible in women with low life satisfaction, and weaker in those with average life satisfaction. In women with its high level, the longer the illness lasted, the lower the BMI; however, this relationship was weak (Table 4, Fig. 1).

Table 4. Moderation analysis (dependent variable: BMI, independent variable: duration of diabetes, moderator: SWLS)

Independent variable	Dependent variable	Moderator	*B*	*SE*	*T*	*P*	Interaction
Duration of diabetes	BMI	SWLS	-0.39	0.05	-7.24	<0.001	β_L = 0.69 (p<0.001) β_A = 0.27 (p<0.001) β_H = -0.15 (p=0.045)

Legend: β – standardised Beta ratio; SE – standard error; *p* – significance; L – low level of SWLS; A – average level of SWLS; H – high level of SWLS

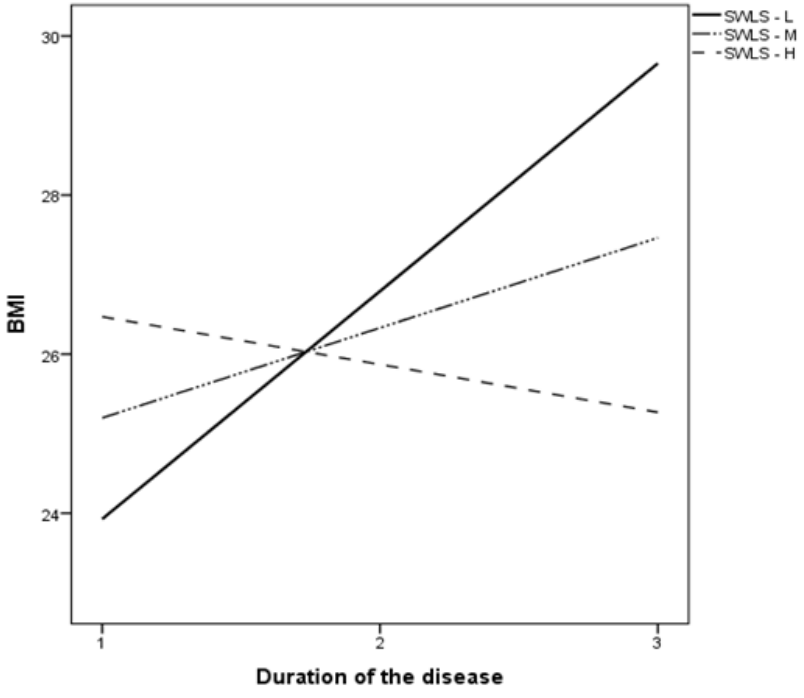

Fig. 1. The BMI level depending on the level of life satisfaction and the duration of illness in women with type 2 diabetes (SWLS: L–low, M–medium, H–high)

It was observed that the volume of physical activity is an important moderator of the relationship between the BMI level and the duration of diabetes. When the volume of physical activity was low or average and the duration of the disease longer, the higher the BMI, however, this relationship was evident in women with low life satisfaction, and weaker in women with its average level. In women with a high volume of physical activity, there were no statistically significant relationships between the duration of diabetes and BMI (Table 5, Fig. 2).

Table 5. Moderation analysis (dependent variable: BMI, independent variable: duration of diabetes, moderator: physical activity)

Independent variable	Dependent variable	Moderator	*B*	*SE*	*T*	*P*	Interaction
Duration of diabetes	BMI	physical activity	-0.16	0.06	-2.74	0.007	β_L = 0.42 (p<0.001) β_A = 0.27 (p<0.001) β_H = 0.12 (p=0.081)

Legend: β – standardised Beta ratio; SE – standard error; *p* – significance; L – low level of SWLS; A – average level of SWLS; H – high level of SWLS

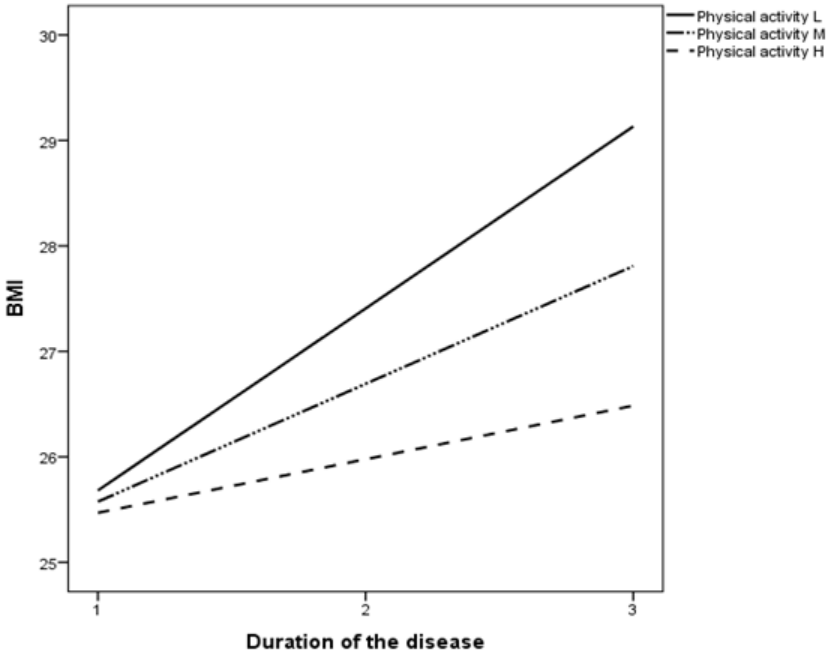

Fig. 2. The BMI level depending on physical activity and the duration of illness in the group of women with type 2 diabetes (PA: L – low, M – medium, H – high)

It was also demonstrated that the women's age is not a statistically significant moderator of the relationship between BMI level and the number of hours devoted to physical activity. For all of the women, a negative correlation was found between physical activity and BMI, which means that the more hours they spent on activity, the lower the body mass. It was also found that in the eldest group, this correlation was no longer statistically significant (Table 6, Fig. 3).

Table 6. Moderation analysis (dependent variable: BMI, independent variable: physical activity, moderator: age)

Independent variable	Dependent variable	Moderator	*B*	*SE*	*T*	*P*	Interaction
Duration of diabetes	BMI	age	0.05	0.06	0.82	0.412	β_L = -0.26 (p=0.001) β_A = -0.21 (p<0.001) β_H = -0.16 (p=0.079)

Legend: β – standardised Beta ratio; SE – standard error; *p* – significance; L – low level of SWLS; A – average level of SWLS; H – high level of SWLS

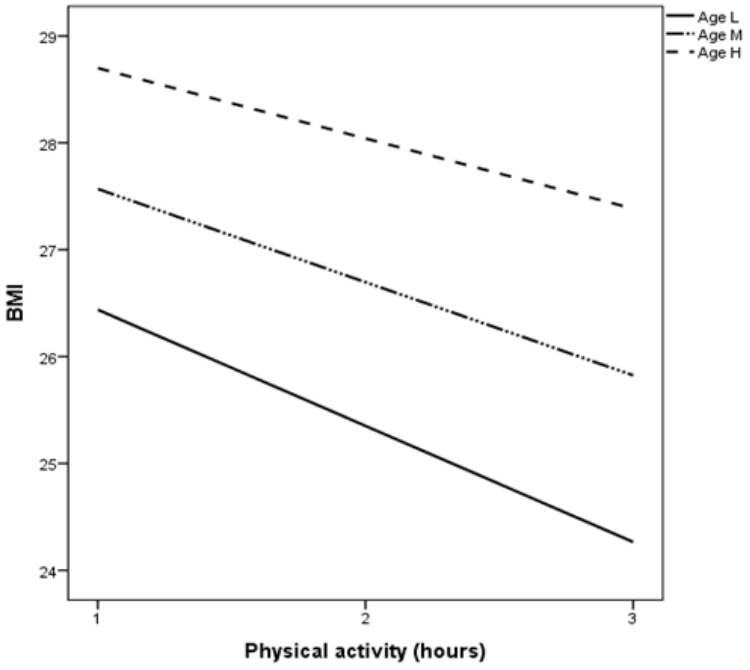

Fig. 3. The BMI level depending on physical activity and the duration of illness in the group of women with type 2 diabetes (PA: L – low, M – medium, H – high)

DISCUSSION

The discussed research, in which it was demonstrated that the mean BMI was 26.71 (±4.14) kg/m^2, has confirmed the prevalence of excessive body mass in women with type 2 diabetes aged 40–65 years. The research also confirmed statistically significant relationships between the BMI value and some of the analysed variables: demographic, health, behavioural and psychological and their configurations. It was also demonstrated that the increase in the BMI along with the age and the duration of the disease was associated with a decrease in the level of life satisfaction, thus, confirming the gradual decline in the quality of women's life during the course of diabetes.

The average value of BMI among women with type 2 diabetes, oscillating at the level of excessive body mass, confirms a significant contribution of overweight and obesity to the aetiology and the course of type 2 diabetes, which is also indicated in other studies [17]. The research by NHANES (National Health and Nutritional Examination Survey) showed that the occurrence of type 2 diabetes became more frequent with increasing BMI in the American population (from 2% with BMI 25–29.9 kg/m^2 to 8% with BMI 30–34.9 kg/m2, and 13% with BMI greater than 35 kg/m2) [20]. Particularly risky is obesity with a so-called abnormal metabolic profile, increasing the risk of rapid development of all components of the metabolic syndrome [21]. The occurrence of visceral obesity in patients with type 2 diabetes is an important factor conducive to metabolic disorders, including dyslipidaemia, reduced glucose tolerance and hypertension [22, 23]. In the examined group of women with type 2 diabetes, the presence of diseases constituting metabolic syndrome was also described (about half of the groups were related to: obesity, hyperlipidaemia and hypertension). Also, earlier studies on somatic indicators and the health status of diabetic patients in Krakow showed an elevated mean BMI level (29.3 kg/m^2) and other health risks (including hypertension – 76.1%,

coronary disease – 46.7% and hyperlipidaemia – 45.7%) [24]. The occurrence of obesity, in almost all patients with T2DM, most often of the abdominal type, has also been confirmed in other studies [9]. Any increase in BMI above the normative value is associated with an increased risk of the occurrence of diabetic complications, which appear at lower BMI values for women than men [10]. Meta-analysis revealed a strong non-linear relationship between BMI and the overall mortality rate in patients with type 2 diabetes [25]. A high BMI level affects the quality of life of people with pre-diabetes [26].

In the authors' research on the analysis of BMI determinants at the level of correlation analysis, the BMI value increased along with age and duration of the disease, while it decreased along with the increase in the level of life satisfaction (the relationships were significant from both sides). At the advanced level of statistical analysis, it was found that apart from the age and the level of life satisfaction, significant predictors explaining the BMI of women also included interactions between factors, including the duration of diabetes with the level of life satisfaction and the volume of physical activity, and the interaction between age and the volume of physical activity. Detailed analysis of the interactional impact of variables on the BMI confirmed the tendency for BMI to increase along with the duration of the disease, especially with a low level of life satisfaction and a decrease in BMI among women with a high level of life satisfaction along with the duration of the disease. Detailed analysis of the interactional impact of variables also confirmed the tendency for BMI to increase at a low and average volume of physical activity along with the duration of the disease (especially at low levels of life satisfaction). It was also shown that in all women, along with an increase in the number of hours devoted to physical activity, the value of BMI decreased.

The demonstrated tendency of an increase in the BMI along with age and the duration of the disease indicates deepening of excessive body mass in the course of diabetes, which can perpetuate the disease, increase insulin resistance and the risk of secondary complications, as noted by other authors [10, 17]. This also suggests a decrease in motivation to control the body mass with age and the passage of time from diagnosis of the disease. Meanwhile, weight reduction is one of the important non-pharmacological treatment methods in type 2 diabetes [27]. The described trends also correspond to the results of epidemiological studies indicating an increase in the prevalence of obesity and its complications with age, including the American [20], Portuguese [28], Iranian [29] and Polish populations [30, 31]. Research conducted in the Polish population (age 20–74), within the framework of the WOBASZ programme, has confirmed that apart from age, the risk of metabolic syndrome increases along with increased BMI and smoking [30]. Studies in Silesia among menopausal women (aged 45–65) also showed an increase in the adipose tissue with age (from 32.15% in those aged 45–49 to 35.5% in the 61–65 age group) [32]. Other studies among adults also showed an increase in BMI and body fat content with age, increasing the risk of metabolic diseases (including lipid and carbohydrate disorders) with coexisting obesity [33]. Research carried out at the Poznań University of Medical Sciences among patients with type 1 diabetes showed a positive correlation between age and WHR and accumulation of glycation products (prognostic indicators for cardiometabolic diabetes complications) [34]. The incidence of obesity increases with age for various reasons, including environmental (low physical activity and sedentary lifestyle, nutritional errors) and socio-economic (easy access to cheaper, highly processed and high-caloric foods) and hormonal reasons (including sex hormone deficiencies) [35, 36]. Relationships between

improper defective food choices (including excessive consumption of yellow cheeses, butter, sweets and sweet carbonated drinks) and an increase in the BMI were also reported among women with type 2 diabetes [37].

The demonstrated tendency for BMI to decline along with an increase in the volume of physical activity of women with type 2 diabetes confirms the role of physical activity in normalising body mass, which is an important element of metabolic control in type 2 diabetes [27]. Physical activity (especially with features of health training) is as a key and integral factor in the prevention and treatment of type 2 diabetes, as it has a positive effect on glycaemic control and improves tissue sensitivity to insulin, lipid profile, body mass and mental state [17]. Physical activity positively affects the control of energy balance, which contributes to the maintenance of proper and/or reduction of excessive body mass (and thus, also the normalization of BMI), which is one of the important aspects of prevention and treatment of obesity and type 2 diabetes [27, 38, 39]. The absolute minimum of physical activity for maintaining health (according to the current WHO standards) for adults (18–64 years) is at least 150 minutes of moderate intensity exercise (5 times, 30 minutes/week) or at least one hour of high intensity exercises (3 times, 20 minutes/week) and strength training with participation of large muscle groups at least twice a week [40]. Also, the American Diabetes Association (ADA) recommends that patients with carbohydrate disorders increase their moderate physical activity to at least 150 min a week (e.g. walks) [39]. American studies among people above the age of 60 with glucose intolerance confirmed that 7-day aerobic exercise resulted in a significant improvement in insulin sensitivity of the tissues (by 53%). Positive changes were independent of changes in body composition, lipid, leptin, adiponectin and catecholamines [41]. Polish research conducted among 119 patients with type 1 diabetes (including 63 women) with at least 5 years of illness, confirmed the positive effect of physical activity on the decrease in accumulation of advanced glycation end-products (AGEs), correlating with the risk of microvascular complications in diabetic patients [34]. On the other hand, Slovakian studies confirmed the links between physical activity and lower values of the body mass index and the improvement in the subjective assessment of the health status among students [42]. Meanwhile, previous studies have confirmed the insufficient level of physical activity of diabetic patients, including those Polish [43], American [27] and Spanish [44]. Among women with type 1 diabetes mellitus, the Małopolska and Podkarpacie regions were dominated by women undertaking physical activity only 1–2 times a week (34%) and never (28%). Everyday physical activity was declared by only 12%, and 3–4 times a week by 26% of respondents [43].

The demonstrated tendency for BMI to decrease along with the increase in the level of life satisfaction of women with type 2 diabetes is justified by the characteristics of this dimension and corresponds to the results achieved in other studies [19]. Satisfaction with life is one of the significant personal resources in the psychosocial health dimension related to human health culture, defined as a subjective indicator of well-being and general individual assessment of the quality of life [19]. Type 2 diabetes negatively affects patients' quality of life, to a greater degree for women than men [12, 45]. The demonstrated positive decreasing trend in the BMI among women more satisfied with life may indirectly indicate a more healthy lifestyle, including more rational dietary choices and higher physical activity, which may be conducive to weight reduction and improvement in mood and state of being (the more so that the study confirmed the decline in BMI) along with an

increase in physical activity and a positive correlation between the volume of physical activity and the level of life satisfaction). The relationships between BMI and the level of life satisfaction demonstrated in the discussed research can be interpreted not only in such a way that a higher level of life satisfaction favours lower BMI values, but also vice versa, because lower BMI values (indicating lower health risks) can also contribute to the improvement in well-being, and thus, the cognitive dimension of life satisfaction (measured by the SWLS scale). Lower values of BMI in women more satisfied with life may intensify the motivation to undertake (and/or continue) pro-health behaviours, conducive to further normalization of health indicators. Polish research, within the framework of the WOBASZ programme, confirmed a lower risk of developing metabolic disorders in women with a higher level of education and life satisfaction [30]. The tendency towards more rational health behaviours, including those with high levels of life satisfaction, has been confirmed by other studies among perimenopausal women [46–49]. Women with high levels of life satisfaction (as well as optimism and self-efficacy) declared significantly more frequent consumption of products with high nutritional density recommended in rational nutrition than women with a low intensity of these factors [46–49]. Similar trends, expressing a positive correlation between the level of life satisfaction and the frequency of consuming recommended products (including vegetables, legume seeds, fruit, whole-grain cereals, dairy products with reduced fat, marine fish and nuts) are described among women with type 2 diabetes. These tendencies can be explained by the relationship between more rational dietary choices and improvement in health, which indirectly translates into better quality of life (and a higher level of life satisfaction), and through more marked motivation to make more favourable food choices by women more satisfied with life [37]. Relationships of life satisfaction with some behavioural health determinants have also been confirmed by Chilean studies [50]. Research among teachers from Wielkopolska also showed that higher levels of life satisfaction were associated with lower BMI values and a more favourable diet [51].

CONCLUSIONS

1. It has been demonstrated that the mean BMI for women aged 40–65 with type 2 diabetes was 26.71 (±4.14) kg/m^2, which confirms the contribution of excessive body mass to the aetiology and the course of the disease.
2. Correlation analysis showed an increase in the BMI along with age and the duration of the disease while a decrease was noted when as the level of life satisfaction among women aged 40–65 with type 2 diabetes increased.
3. Analysis of the interactional impact of variables on the BMI confirmed an increase in the BMI along with the duration of the disease, low levels of life satisfaction and low as well as average levels of physical activity. Furthermore, a decrease in the BMI level was noted along with an increase in the volume of physical activity of women aged 40–65 years with type 2 diabetes.
4. The value of the indicator in women aged 40–65 with type 2 diabetes shows significant correlations with age, the duration of the disease, the volume of physical activity and the level of life satisfaction, with an indication of an interactive and moderating influence of some variables.

In conclusion, it can be said that analysis of the predictive significance of selected somatic, health, behavioural and psychological factors in relation to BMI can be a guide for predicting changes in BMI and increasing the effectiveness of therapeutic interactions. At the same time, however, the limited number of the considered variables potentially explaining the variability of the BMI index

should be highlighted. Studies aimed at understanding and analysing the broader context of these dependencies could also take other variables into account, including gender, socio-economic factors, a greater number of behavioural factors (not only physical activity, but also diet and other health-related behaviours) and those psychological (not only level of life satisfaction, but also, other personal resources). Therefore, it is suggested that further research should be considered including a broader spectrum of factors explaining BMI (environmental, behavioural and psychological) levels among patients with metabolic diseases, including type 2 diabetes. Understanding and analysis of environmental, behavioural and psychological determinants of other (apart from the BMI) health indicators among diabetic patients can also be an important area of research.

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