CHANGE IN QUALITY OF LIFE IN MEDICAL STUDENTS ACROSS GRADUATION: RESULTS OF POLLEK STUDY

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Abstract

Objectives: Medical students experience numerous demands during the education process, which determine their quality of life (QoL). In particular, the first years of medical studies are a challenge for students. This paper aims to identify and evaluate the quality of life with simultaneous assessment of their determinants in Polish medical students in Poland during longitudinal observation. **Material and Methods:** The authors analyzed data collected from the first follow-up of the cohort study named POLLEK (Polski Lekarz – The Polish Physician) conducted among medical students at the Medical University of Silesia in Katowice, Poland. The QoL was assessed using the abbreviated version of the *World Health Organization Quality of Life Test – Bref* (WHOQOL-BREF) questionnaire. Students were followed at 2 points of time: in their first year of studies – the academic year 2021/2022 (T1) (N = 427), and then in their second year – the academic year 2022/2023 (T2) (N = 335). **Results:** Changes in QoL indicators were analyzed using paired data. A significant decrease in the QoL scores in the somatic and psychological domain in T2 was observed, while scores in the environmental domain showed an increase by T2. In addition, it was found that better self-rated health (SRH), higher physical activity (PA), and better socioeconomic status (SES) were the key determinants of higher quality of life domains across both T1 and T2 domains. **Conclusions:** In conclusion, although the overall QoL remained stable throughout the observation period, the QoL in the somatic and psychological domains deteriorated among medical students between T1 and T2. However, there was a slight improvement in the environmental domain during the second year. The observations suggest that medical schools should actively promote a balance between schoolwork and the personal life of medical students, and courses on coping with difficult, stressful situations. These activities should be introduced at an early stage of medical education. Int J Occup Med Environ Health. 2024;37(5):495–507

Key words:
follow-up study, medical students, health status, mental health, quality of life, graduation

INTRODUCTION

The quality of life (QoL) and mental health of medical students have been of interest to the scientific community for several years, however, the research in this field is mostly conducted based on a cross-sectional nature. The potential health problems considered in future physicians are particularly manifested by chronic fatigue and burnout syndromes and are related to stress exposure in the workplace environment [1]. In particular, it was stated that job-related stress among healthcare workers constitutes a signifi-

cant occupational health problem [2], physicians encounter high levels of stress and burnout. Additionally, trainee physicians are also classified as a high-risk group [3]. What is more, even medical students and young doctors are at increased risk of alcohol addiction, risky alcohol consumption, depression, and suicidal tendencies [1].

The QoL and general health of medical students have been the subject of the POLLEK study (Polski Lekarz – The Polish Physician) since 2019. The authors have previously found that the QoL of the first-year medical students was

affected by the change to remote learning during the COVID-19 pandemic. This impact was observed mainly in terms of somatic and environmental domains [4]. In this research, another crucial issue under analysis pertains to patterns of alcohol use and psychological well-being. The authors previously reported that 30.9% of first-year students engaged in risky alcohol consumption [5], and additionally, half of them experienced distress [6].

Measurement of QoL in research practice is usually based on multidimensional procedures, requiring combining indicators from various scientific fields. Health-related QoL (HRQoL) is an important and widely used concept in medical and health sciences. It focuses on health determinants that impact QoL, assessing the value placed on life expectancy. The HRQoL is adjusted by impairments, functional abilities, perception, and opportunities, and is mainly influenced by factors including the occurrence of disease, injury, treatment, and health policy [7]. Initial recognition of the QoL remains an important issue for developing effective mental and physical health prevention strategies in future medical doctors. It is worth considering what factors are related to the QoL in medical students. For instance, the most frequent predictors of it observed in Brazilian medical students were mainly associated with gender and year of study. Nevertheless, factors such as economic class, educational environment, academic efficacy, depression, burnout, resilience, empathic concern, sleep difficulties, chronic illness, body mass index, and leisure-time physical activity also contribute significantly to the assessment of QoL [8]. Concerning the year of study, medical students have been shown to experience significant changes in mental health during the early years of their studies. The prospective analyses indicated that physical, emotional, and overall health significantly declined the most during the medical training. Students reported high levels of depression, anxiety, and burnout as early as the first year of medical school [9]. It is worth adding that the first year of college is associated with transitioning from adolescence to adulthood, presenting numerous challenges. Medical students showed higher levels of stress, depression, and anxiety in comparison to students in engineering and arts [10]. For instance, 71% of students who were surveyed in the pre-clinical year met the criteria for burnout [11]. Students experiencing burnout are more likely to have symptoms of depression and fatigue [12]. However, another study suggested that QoL improved throughout the course, with greater satisfaction in the sixth year, which corresponds to higher resilience [13].

During the analyzed period in Poland, the Medical University of Silesia in Katowice (MUoS) was one of the largest and most established medical universities in Poland, with a long-standing tradition. The number of new medical graduates is an important indicator in assessing the number of new entrants into the medical profession who will replace retiring doctors and respond to current or future shortages. The number of new medical graduates has increased in all Organisation for Economic Co-operation and Development (OECD) countries since 2000 but with varying tendencies [14]. Despite this, the Polish healthcare system nowadays faces an outflow of medical staff from public hospitals, including physicians. This process is significantly related to the demanding nature of their work. Long working hours and high levels of stress appear to be affecting doctors' physical and mental health. Thereupon, the revision of the Declaration of Geneva (2017) was introduced, emphasizing the connection between a doctor's well-being and their ability to provide high-quality patient care [15]. To address the needs of doctors, the Standing Committee of European Doctors (Comité Permanent des Médecins Européens – CPME) has presented recommendations promoting doctors' work-life balance and a supportive environment [16]. As mental health problems begin early in medical training, interventions that prevent burnout are needed at all stages of a physician's career to ensure well-being over a lifetime [17].

In light of the knowledge available, no prospective cohort study on the QoL and mental health of medical students

and physicians has been conducted within the Polish population. The presented study has the potential to shed new light on the changes in medical students' QoL over time, considering a spectrum of determinants and risk factors, with a particular focus on the differences across various years of study.

MATERIAL AND METHODS

Objective

As it was previously mentioned, the presented paper aims to identify and evaluate the QoL with simultaneous assessment of their determinants in Polish medical students from MUoS during longitudinal observation. Additionally, in the model of the epidemiological cohort study, control of the sociodemographic factors and those that identify lifestyle and health status has been planned.

Methods

Study design

The authors present the analysis of newly collected data from the first follow-up of the POLLEK cohort study conducted among medical students at the MUoS in Katowice, Poland. The authors' previous papers have reported the results from the initial, cross-sectional phases of the POLLEK study [4–6]. The primary contribution of the current database is that the data were collected from the same group at different time points, enabling longitudinal observation of the phenomena under study. All students entering this medical school in the academic year 2021/2022 were invited to participate. They were followed at 2 points of time: in their first year of studies (the academic year 2021/2022) (T1), and then in their second year (the academic year 2022/2023) (T2). The next stage of this study is planned for the same students in their fourth year of medical studies (T3). The total number of participants in the first period (T1) was 427 (83.7% response rate) while in the second period (T2) was somewhat lower, N = 335 (83.8% response rate). The dropout rate during the observation period was 21.5% – mainly due to students' withdrawal from studies (N = 87) or lack of attendance during the measurement day (N = 5). Data were collected by a paper-form questionnaire, and written informed consent was obtained from all participants. Each study participant was assigned a unique, anonymous identifier (ID), which also appeared on the paper forms distributed to participants. The purpose of implementing IDs was to ensure the possibility of conducting follow-ups at subsequent time points in the study while maintaining complete anonymity. The study was conducted with the approval of the Bioethics Committee of the Medical University of Silesia in Katowice (No. KNW/0022/KB/217/19, November 8, 2019).

Measures

The POLLEK questionnaire consisted of items concerning the QoL, the prevalence of hazardous alcohol use, sociodemographics (age, sex, marital status, current financial situation, current place of residence during medical studies), lifestyle indicators (current traditional or electronic cigarette smoking, selected eating behaviors such as consumption of meals containing animal proteins and consumption of fruit and vegetables, and frequency of physical activity), as well as health (self-declared health status, chronic diseases, body weight, and height facilitating the calculation of body mass index (BMI)).

The dependent variable, the QoL was measured in 4 domains (somatic–physical health, psychological, social–social relationships, and environmental) by a validated instrument which was the Polish, generic version of the *World Health Organization Quality of Life Test – Bref* (WHOQOL-BREF) questionnaire [18]. Respondents were asked how they classify particular aspects of their QoL to assess them as satisfactory or problematic using a 5-point Likert scale in each question. The questionnaire comprises 26 items evaluating QoL across 4 domains: somatic (physical health), psychological, social (social rela-

tionships), and environmental. The somatic domain includes factors such as energy levels, fatigue, mobility, pain and discomfort, the need for medical treatment, sleep quality, and satisfaction with work capacity. The psychological domain covers aspects like body satisfaction, appearance, and the frequency of both negative and positive emotions in daily life. The social relationships domain addresses satisfaction with personal relationships, social support, and sexual activity. The environmental domain includes questions about physical safety and security, financial resources, accessibility, the quality of social and healthcare services, satisfaction with the home and physical environment, opportunities for leisure activities, and transportation. As per the recommendation of WHO, the raw values were transformed into a scale of 0–100 pts. The approval to use the Polish version of the WHOQOL-BREF questionnaire in the POLLEK study has been obtained from the WHO.

The prevalence of hazardous alcohol use among medical students was assessed using a Polish version of the *Alcohol Use Disorder Identification Test* (AUDIT) questionnaire developed in 1989 by the WHO. This is a simple and well-known 10-item screening tool for excessive alcohol drinking [19]. It consists of 3 main domains: recent alcohol use, alcohol dependence symptoms, and alcohol-related mental and physical problems. Each item has a score ranging 0–4 and the maximum possible score is 40. Hazardous alcohol drinking was identified in students with a score of ≥8 pts [5].

Statistical analysis

The qualitative variables were presented by the number of observations and frequency, and the quantitative variables that identified particular QoL domains were described as mean values (M), standard deviations (SD), and ranges. Due to the distribution of variables deviating from normality (Shapiro-Wilk test), the Wilcoxon signed-rank test for paired variables was employed to assess differences

in the QoL between time points T1 and T2. Additionally, the number of paired observations was revealed. Finally, multivariable linear regression models were used to assess the determinants of QoL at T1 and T2. Two separate regression models were calculated, each using only the sample with follow-up data. The dependent variables were the particular QoL domains, while the independent variables considered in the models were sociodemographic data (sex, marital status, current financial situation, current place of residence during studies at university), self-declared lifestyle, and health status. All variables included in the regression model met the criteria for a statistical significance of 0.1 in univariate analyses. However, the level of statistical significance in multivariable analyses was considered at p < 0.05. All statistical analyses were conducted using the Statistica 13.3 package (TIBCO Software Inc., Palo Alto, CA, USA). For statistical interpretation and regression analysis, the original categories of selected variables referred to the 5-point Likert scale (current financial situation, self-rated health) were recoded into dichotomous values.

RESULTS

Table 1 presents sociodemographic variables, lifestyle data, and health state information in both study periods. The majority of research participants were female and single at both time points. Most respondents declared a good financial situation and lived in a dormitory or rented flat throughout the follow-up observation period. Furthermore, cigarette smoking was reported by 23.4% of students at T1, increasing to 27.5% by their second year of studies. Hazardous alcohol drinking showed a slight rise, from 30.0% at T1 to 32.8% at T2. Additionally, the prevalence of chronic disease diagnosed by a medical doctor rose from 23.7% at T1 to 28.4% at T2. The percentage of participants with a BMI ≥ 25.0 also increased, from 13.1% at T1 to 15.5% at T2. More individuals were living in a relationship by the second year of follow-up, with 29.3% at T2

Table 1. Description of the selected personal characteristics at T1 noted as referring to authorial questions from POLLEK (Polski Lekarz – The Polish Physician) questionnaire, among medical students at first year of studies (the academic year 2021/2022) (T1) and second year (the academic year 2022/2023) (T2), Medical University of Silesia in Katowice, Poland

Variable	Participants (N = 762)			
	T1 (N = 427)		T2 (N = 335)	
	n	%	n	%
Sociodemographic				
sex				
women	289	67.7	226	67.5
men	138	32.3	109	32.5
marital status				
in relationship	99	23.2	98	29.3
single	319	74.7	230	68.7
missing data	9	2.1	7	2.1
current financial situation				
poor	115	26.9	88	26.3
good	312	73.1	246	73.4
missing data	0	0.0	1	0.3
current place of residence during studies at university				
family home	124	29.0	87	26.0
dormitory/rented flat or room	303	71.0	247	73.7
missing data	0	0.0	1	0.3
Lifestyle				
current cigarette smoking (traditional or electronic)				
yes	100	23.4	92	27.5
no	326	76.3	241	71.9
missing data	1	0.2	2	0.6
hazardous alcohol use				
hazard use	128	30.0	110	32.8
low risk	274	64.2	215	64.2
missing data	25	5.9	20	6.0
number of meals containing animal protein				
all	53	12.4	45	13.4
3/4	191	44.7	150	44.8
<3/4	183	42.9	140	41.8
consumption of fruit and vegetables				
daily				
≥3 meals	85	19.9	67	20.0

Table 1. Description of the selected personal characteristics at T1 noted as referring to authorial questions from POLLEK (Polski Lekarz – The Polish Physician) questionnaire, among medical students at first year of studies (the academic year 2021/2022) (T1) and second year (the academic year 2022/2023) (T2), Medical University of Silesia in Katowice, Poland – cont.

Variable	Participants (N = 762)			
	T1 (N = 427)		T2 (N = 335)	
	n	%	n	%
Lifestyle – cont.				
consumption of fruit and vegetables – cont.				
≥2 meals	198	46.4	155	46.3
less often	142	33.3	113	33.7
missing data	2	0.5	0	0.0
frequency of physical activity				
high	347	81.3	265	79.1
low	79	18.5	69	20.6
missing data	1	0.2	1	0.3
Health indicators				
self-rated health				
worse	175	41.0	131	39.1
good	251	58.8	204	60.9
missing data	1	0.2	0	0.0
ever-diagnosed chronic disease				
yes	101	23.7	95	28.4
no	324	75.9	240	71.6
missing data	2	0.5	0	0.0
body mass index (BMI)				
≤24.9	371	86.9	277	82.7
≥25.0	56	13.1	52	15.5
missing data	0	0.0	6	1.8

compared to 23.2% at T1. Finally, the mean age at T1 was 20.0 years (SD = 1.8), and at T2, M±SD 20.8±1.6 years. Table 2 presents the obtained scoring in particular domains of WHOQOL-BREF in research participants at T1 and T2. It was indicated that the QoL score significantly decreased in their second year of studies in the somatic ($p < 0.001$) and psychological domains ($p < 0.001$). On the other hand, the scoring for the environmental domain was higher among students followed at T2. However, no significant differences were determined between particular time points for the overall Qol ($p = 0.4$) and social relationship domain ($p = 0.4$).

In the next step, the determinants of the QoL at T1 and T2 were tested in the multivariable regression models and the results are shown in Table 3. The authors have found that the total scoring of the overall QoL among medical

Table 2. The *World Health Organization Quality of Life – Brief* (WHOQOL-BREF) standardized scores among medical students at first year of studies (the academic year 2021/2022) (T1) and second year (the academic year 2022/2023) (T2), Medical University of Silesia in Katowice, Poland

Quality of life domain	WHOQOL-BREF score [pts]				Z^a	p^a
	T1		T2			
	M±SD	min.–max	M±SD	min.–max		
Overall quality of life (N = 332)	68.6±17.9	12.5–100.0	69.0±17.0	12.5–100.0	0.72	0.4
Somatic (N = 326)	62.8±15.2	21.4–96.4	45.0±12.3	10.7–75.0	13.79	<0.001
Psychological (N = 323)	62.2±16.8	12.5–100.0	49.9±11.1	20.8–79.2	9.11	<0.001
Social relationships (N = 329)	69.5±18.6	0.0–100.0	69.3±19.1	0.0–100.0	0.83	0.4
Environmental (N = 331)	64.4±12.6	21.9–93.8	66.2±13.6	25.0–96.9	3.20	0.001

N – number of paired observations in the Wilcoxon test.
WHOQOL-BREF score 0–100 pts.
[a] Results of the Wilcoxon test.

Table 3. Significant predictors of the *World Health Organization Quality of Life – Brief* (WHOQOL-BREF) domains among medical students at first year of studies (the academic year 2021/2022) (T1) and second year (the academic year 2022/2023) (T2), Medical University of Silesia in Katowice, Poland

Variable	β	95% CI	p^a
T1 (2021/2022)			
overall quality of life (N = 388, R^2 = 0.33, p < 0.001[b])			
current traditional or electronic cigarettes smoking (1 – yes, 2 – no)	0.17	0.09–0.26	<0.001
self-rated health (1 – worse, 2 – good)	0.47	0.38–0.55	<0.001
somatic (N = 380, R^2 = 0.33, p < 0.001[b])			
frequency of physical activity (1 – high, 2 – low)	−0.18	−0.26–(−0.09)	<0.001
ever diagnosed chronic disease (1 – yes, 2 – no)	0.12	0.03–0.21	0.004
self-rated health (1 – worse, 2 – good)	0.39	0.30–0.48	<0.001
psychological (N = 378, R^2 = 0.17, p < 0.001[b])			
self-rated health (1 – worse, 2 – good)	0.33	0.23–0.43	<0.001
social relationships (N = 383, R^2 = 0.15, p < 0.001[b])			
marital status (1 – in relationship, 2 – single)	−0.27	−0.37–(−0.17)	<0.001
self-rated health (1 – worse, 2 – good)	0.23	0.13–0.34	<0.001
environmental (N = 388, R^2 = 0.23, p < 0.001[b])			
current financial situation (1 – poor, 2 – good)	0.32	0.23–0.42	<0.001
frequency of physical activity (1 – high, 2 – low)	−0.12	−0.21–(−0.02)	0.01
self-rated health (1 – worse, 2 – good)	0.20	0.10–0.29	<0.001
T2 (2022/2023)			
overall quality of life (N = 298, R^2 = 0.28, p < 0.001[b])			
self-rated health (1 – worse, 2 – good)	0.43	0.32–0.53	0.001
ever-diagnosed chronic disease (1 – yes, 2 – no)	0.12	0.02–0.22	0.01

Table 3. Significant predictors of the *World Health Organization Quality of Life – Brief* (WHOQOL-BREF) domains among medical students at first year of studies (the academic year 2021/2022) (T1) and second year (the academic year 2022/2023) (T2), Medical University of Silesia in Katowice, Poland – cont.

Variable	β	95% CI	p[a]
T2 (2022/2023) – cont.			
somatic (N = 300, R^2 = 0.18, p < 0.001[b])			
current financial situation (1 – poor, 2 – good)	0.20	0.07–0.31	0.001
frequency of physical activity (1 – high, 2 – low)	−0.14	−0.25–(−0.03)	0.008
self-rated health (1 – worse, 2 – good)	0.19	0.08–0.30	<0.001
psychological (N = 298, R^2 = 0.08, p = 0.007[b])			
sex (1 – women, 2 – men)	−0.14	−0.26–(−0.02)	0.02
BMI (1: ≤24.9, 2: ≥25.0)	−0.17	−0.29–(−0.05)	0.003
social relationships (N = 299, R^2 = 0.17, p < 0.001[b])			
marital status (1 – in relationship, 2 – single)	−0.25	−0.36–(−0.15)	<0.001
frequency of physical activity (1 – high, 2 – low)	−0.11	−0.21–0.00	0.04
self-rated health (1 – worse, 2 – good)	0.18	0.06–0.29	0.001
number of meals containing animal protein (1 – all/3/4 meals, 2 – <3/4 meals)	−0.15	−0.27–(−0.04)	0.006
environmental (N = 297, R^2 = 0.26, p < 0.001[b])			
current financial situation (1 – poor, 2 – good)	0.39	0.29–0.49	<0.001
self-rated health (1 – worse, 2 – good)	0.17	0.06–0.28	0.001

R^2 – determination of the model.
[a] Significance to the reference group. [b] Significance of the multivariable regression model.

students at T1 was significantly associated with current cigarette smoking and self-rated health. It is worth noting that worse self-rated health in research participants during the first year of their studies was related to a worse QoL in all domains. What is more, the analysis conducted in their second year of studies confirmed the relationship between worse overall QoL and diagnosis by physician chronic disease. Nevertheless, the level of QoL in the field of psychological domain at T2 was significantly associated with sex and BMI. Additionally, higher physical activity translated, in the first year of the study, to a higher score in the somatic (p < 0.001) and the environmental (p = 0.01) domains of the QoL. In the second year of the study, such a relationship was observed for the somatic (p = 0.008) and social relationships (p = 0.04) domains. The worse financial situation of medical students was also an important factor de-

termining the lower level of QoL in the environmental domain at T1 (p < 0.001) and at T2 in the somatic (p = 0.001) and environmental domains (p < 0.001).

DISCUSSION

This study aimed to identify and evaluate the QoL of Polish medical students throughout the 2 first years of studies, that is during the basic, preclinical phase in the medical training program. As mentioned in the introduction, this is the first study examining the QoL in this population using a prospective model. The authors' analyses indicated a significant deterioration in the QoL of medical students, particularly in the somatic and psychological domains, during the first 2 years of study. Conversely, in the environmental domain, scores showed an increase. Considering the factors determining the QoL during the obser-

vation period, it was shown that factors such as self-rated health, level of physical activity, and current financial situation were associated with assessing the particular domains of students' QoL in the first and second year of their studies. In the second year of observation, it is worth paying attention to the significant impact of sex and BMI on the level of QoL in the psychological domain. Moreover, the psychological domain received the lowest score in the second year of studies, whereas in the first year of observation, it was the somatic domain that was assessed as the lowest. The social relationships domain was rated highest both in their first and second year of studies. Reports from other prospective studies seem to support these findings. In the research conducted among medical students in Brazil, the WHOQOL-BREF questionnaire was also used. The cited study demonstrated that the psychological domain consistently received the lowest perception of QoL throughout the entire study period, spanning from the first to the sixth year of studies. Moreover, scores in the psychological and somatic domains were lower in the second year than in the first [13], this observation corresponds with the authors' findings. Conversely, while Brazilian students perceived a decline in their QoL within the environmental domain during their second year of studies, Polish students demonstrated improvement compared to their first year. Improvement in conditions in their place of living, increase in satisfaction with transport, better access to health services, and increase in subjective perception of safety in daily life may result in higher QoL scores in the environmental domain in the second year of students in this research. It is worth noting that the first years of medical studies are particularly difficult for students. The findings from a qualitative study involving 68 German medical students reveal that the transition from school to university is marked by significant personal challenges, particularly in relation to the experience of living alone for the first time. Especially in the initial period of their study, there was a constant perception of stress, including financial strain [20]. Howev-

er, the relationship between the year of study and the QoL and mental health is difficult to determine. For instance, in the cross-sectional study by Ramadianto et al., the prevalence of mental health issues in Indonesian medical students has been investigated. They observed higher scores of depression and anxiety among first-year students and those in the initial year of the clinical phase [21]. On the other hand, in the research of Ofei-Dodoo et al. [12], symptoms of depression were least prevalent among first-year medical students and increased among their fourth-year. In this study, the level of QoL has been also assessed. The highest scores for QoL were observed in first-year students. Among second to fourth-year students, the QoL remained lower than in the first year, which aligns with the findings of the authors' research [12]. Similar were the results of a study conducted by Kjeldstadli et al., which indicated that the satisfaction levels among medical students decreased from the first to the third year, persisting at this lower level until graduation. Furthermore, students maintaining a high level of life satisfaction were less prone to employing emotion-focused coping strategies, such as wishful thinking, compared to their peers [22].

A very significant question to consider is: does the QoL of medical students decrease during the second year in medical school? Many explanations focus on factors specific to university education, including financial and accommodation concerns, high scores of perceived exam stress, and high expectations and demands for medical students. Available published data suggest that the QoL of medical students was also related to study characteristics, such as their level of satisfaction with supervision and the experience of failing medical school exams [23]. Moreover, the results of the studies used the *Dundee Ready Education Environment Measure* (DREEM) scale pointed out that the scoring of QoL life depends on perceptions of teaching, teachers, academic self-perception, the educational atmosphere, and social self-perception [24,25]. In addition, some of the results of the Polish study have shown

that higher fatigue would be associated with a lower level of satisfaction with medical studies, QoL, and a higher level of stress [26].

Another important issue that corresponds to the QoL of medical students is sleep restrictions. The study conducted during 2 different periods (classes with insufficient and vacations with sufficient sleep) demonstrated that sleep deprivation is associated with functional impairment and poor academic outcomes. This led to a reduction in the level of attention, with a potentially negative impact on academic performance [27]. A Brazilian study indicated that 62.6% of medical students reported poor sleep quality. In this study, sleep deprivation and daytime sleepiness were linked with a worse perception of QoL and educational environment, depression, and anxiety [28]. In some situations, sleepiness may be even associated with lower empathy and higher levels of occupational burnout [29]. This example demonstrated that the QoL of medical students should also be considered within the framework of personality determinants. For instance, higher QoL was significantly associated with greater extraversion, while increased agreeableness was linked to its lower levels [30]. Moreover, about 13% of Chinese university students reported the presence of suicidal ideation. A positive correlation between neuroticism, psychoticism, impulsivity, aggression, and suicidal ideation has been indicated, whereas extroversion was negatively associated [31]. In addition, the experience of social isolation, i.e., during examination sessions, may be difficult for medical students with a high level of extroversion to cope with [20].

In relation to the prevalence of emotional disorders, it has been noted by Moutinho et al. [32] that almost half of the students demonstrated high levels of depression, anxiety, and stress during the 2-year follow-up period. This study also demonstrated that medical students with low income declared a poorer QoL [32]. Such an observation is consistent with the authors' findings which revealed that higher QoL scores were linked with a good financial sit-

uation. Furthermore, stress, depression, and anxiety observed at the commencement of medical training were associated with the prevalence of the same mental health problems reported in the subsequent years [32].

In terms of protective factors for the QoL among medical students, it has been proven that time management plays a significant role. It should be taken into consideration when designing interventions to improve the QoL among medical students, including free time for study and leisure, and activities for students to develop time management skills [33]. It seems to be very important because medical students may be inclined to be unable to enjoy leisure time due to feelings of guilt [20]. Therefore, promoting a culture of well-being in this population is essential. Medical curriculum content should include areas related to such as QoL, well-being and mindfulness, and prevention of stress and burnout [17]. It should also be noted that the effectiveness of mindfulness-based preventive interventions on anxiety and depression, stress, burnout, QoL, and suicidal ideation in medical students and junior doctors remains unconfirmed [34].

Investigating how physical activity is associated with burnout and QoL in medical students represents another crucial and equally important research area. Taylor et al. [35] conducted a large systematic review of articles addressing both physical activity and burnout or QoL among medical students. Ultimately, 18 studies involving 11 500 medical students from 13 countries were subjected to analysis. It was found that physical activity showed a negative association with burnout and a positive association with QoL. Furthermore, the results suggested a dose-response effect of physical activity on both burnout and QoL; higher intensities and frequencies were associated with greater improvements in outcomes. Based on the findings of this study and the authors', it can be summarized that engaging in physical activity is linked to decreased burnout and enhanced QoL among medical students. However, there is a lack of research on the ideal intensity, frequen-

cy, volume, and type of physical activity. Integrating physical activity into medical education may enhance well-being and better equip students for the challenges of medical practice [35].

Strengths and limitations of this study

The main strength of this study is that a prospective observation has been used, following changes and determinants of QoL between the first and second year of medical studies among a cohort of students of one of the largest medical faculty in Poland. In addition, the participation rates both in the first and second periods were high (83.7% response rate at T1 and 83.8% response rate at T2). However, the number of students participating at T2 was lower (N = 335) than at T1 (N = 427). So, 92 of the students dropped out of the sample during the research period. Dropout may constitute a certain limitation in the next stage of this study, which is planned for the same students in their fourth year of medical studies (T3). In further analyses, it would be worthwhile to use mixed regression models for repeated data to identify the determinants of QoL changes that occur during medical studies. Finally, since the data obtained in the study were been collected from a single education center, the results may not be generalizable to the entire population of medical students in Poland.

CONCLUSIONS

In conclusion, although the overall QoL index remained stable throughout the observation period, the QoL in the somatic and psychological domains deteriorated among medical students between their first and second years of study. However, there was a slight improvement in the environmental domain during the second year. The authors' observations suggest that medical schools should actively promote a balance between schoolwork and the personal life of medical students, and courses on coping with difficult, stressful situations. These activities should be introduced at an early stage of medical education.

Author contributions

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