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ORIGINAL ARTICLE

Knowledge, attitudes, and perceptions of obesity management among medical students: a multicenter study in Saudi Arabia

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ABSTRACT

Background: Obesity is a major global health issue, with a prevalence of 33.7% in Saudi Arabia. Medical students must be adequately prepared to manage obesity, including both lifestyle changes and bariatric surgery. However, inconsistencies in medical education and limited exposure to obesity management may affect their competency. This study assessed medical students' knowledge and attitudes towards obesity in Saudi Arabia, focusing on differences between junior- and senior-year students and their views on bariatric surgery.

Methods: A cross-sectional survey was conducted on 225 medical students from Riyadh, Jeddah, and Hail using a validated questionnaire. Data were analyzed in RStudio (version 4.3.1). Categorical variables were reported as frequencies and percentages. Group comparisons were made using Fisher's exact test or Pearson's chi-square test. The Wilcoxon rank-sum and Kruskal-Wallis tests were used to assess factors affecting knowledge scores. A p-value < 0.05 was considered statistically significant.

Results: Among respondents, 77.8% were female, and 74.7% were sixth-year students. Riyadh students had significantly higher knowledge scores than those in Jeddah and Hail (median = 8.00; p = 0.010). Senior students demonstrated better knowledge of diagnostic criteria and surgical complications (p < 0.05). Male students more frequently recommended appropriate physical activity (p = 0.008). Time constraints during clinical rotations were reported by 40.4% as a barrier to effective obesity management.

Conclusion: Knowledge, attitudes, and perceptions regarding obesity among Saudi medical students vary by academic level and region. These findings highlight the need for more standardized and comprehensive obesity education across medical schools.

Keywords: Obesity, medical students, management.

Introduction

Obesity continues to pose a major global public health challenge, with the World Health Organization estimating that over 1 billion people were living with obesity in 2022, including approximately 890 million adults, or 16% of adults aged 18 years and above [1,2]. In Saudi Arabia, the ratios are more alarming, 33.7% with obesity [3]. International trends also point to an increasing burden of obesity globally, with forecasts that by 2035, almost one-quarter of people worldwide will be obese [4]. Obesity classification is based on the Body Mass Index (BMI), which classifies obesity as Class I (BMI 30-34.9 kg/m²),

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Class II (BMI 35-39.9 kg/m²), or Class III (BMI ≥40 kg/m²) [5].

Several complex and related factors are known to contribute to the pathogenesis of obesity, including genetic predispositions, sedentary lifestyles, and high-fat diets [6]. Long exposure to these risk factors can intensify the danger of several chronic diseases, including cardiovascular disease, type 2 diabetes mellitus, hypertension, obstructive sleep apnea, etc. [7]. Management interventions for obesity range from behavioral modifications and pharmacologic therapies to surgical approaches in more severe cases [8,9]. In general, behavioral interventions target reductions in caloric intake and increases in physical activity (PA) and are effective in maintaining weight loss (WL) [10,11]. In case of failure of these measures, pharmacologic therapies can be added, with bariatric surgery being the therapy of last resort for those with more advanced obesity and obesity-associated comorbidities [12-15]. Bariatric surgery remains the most effective treatment for advanced obesity and related comorbidities. It is indicated according to evidence-based guidelines such as the 2022 American Society for Metabolic and Bariatric Surgery and International Federation for the Surgery of Obesity and Metabolic Disorders joint statement on surgical indications, which emphasizes patient selection criteria and multidisciplinary management to optimize outcomes [14-18].

Despite the expanding incidence of obesity and its medically harmful effects, medical training often neglects obesity as a topic [19-22]. Surveys have demonstrated that almost half of medical schools worldwide lack a dedicated curriculum for obesity due to factors such as limited time, lack of specially trained faculty, low student demand, and dissatisfaction amongst faculty with expertise in obesity and/preventive medicine [23-25]. Although knowledge of the health consequences of obesity is generally well understood by medical students, there are gaps in awareness of treatment options and efficacy [26]. The authors aimed to explore medical students' views and experiences regarding obesity management, including both surgical and non-surgical interventions. The study aimed to identify educational gaps and guide strategies to optimize weight-related education in the medical school curriculum by comparing students at different levels of academic training.

Methods

Study design and setting

This cross-sectional investigation was conducted across medical colleges in three Saudi Arabian cities: Riyadh, Jeddah, and Hail. These locations were strategically chosen to capture a broad, regionally diverse sample of medical students, as they were home to the largest universities in the central, southern, and western regions.

Study population

The study population comprised medical students from both junior and senior years, representing both male and female genders. Eligibility criteria included active enrollment in medical programs within the selected cities. Excluded were non-medical students, first-year medical students, and postgraduate trainees**.**

Sample size and sampling

The minimum required sample size was estimated in the RaoSoft calculator using the standard formula for single-proportion studies: $n_0 = Z^2 \times p(1 - p) / d^2$, where Z is the standard normal deviate at the desired confidence level, p is the expected response distribution, and d is the margin of error. Using a confidence level of 95% ($Z = 1.96$), a margin of error of 5% ($d = 0.05$), and a 50% response distribution ($p = 0.50$), the initial sample size was determined as $n_0 = (1.96)^2 \times 0.50 \times 0.50 / (0.05)^2 = 384.16$. Since the source population was finite, a finite population correction was applied to the sample size using the finite population correction formula: $n = n_0 / [1 + (n_0 - 1) / N$. Based on an estimated accessible population (N) of 520 eligible medical students across the participating colleges, the corrected minimum sample size: $n = 384.16 / [1 + (384.16 - 1) / 520 = 221.18$, which was rounded up to 222 participants. To account for anticipated non-response or incomplete responses, the target sample was increased to 300 participants. Participants were recruited using a convenience sampling approach, in which eligible medical students from institutions in each city were invited to participate via an electronic questionnaire.

Data collection

Data collection was conducted from [26/11/2023] to [7/2/2024] using a validated questionnaire, adapted with prior permission from the instrument used by Martins and Norsett-Carr [26] in their research on obesity knowledge among medical students. The survey collected data on participants' knowledge of obesity management, perceptions of management approaches, and attitudes toward bariatric surgery. The questionnaire was distributed electronically and included sections on demographics, knowledge assessment items, and attitudinal items.

Variables

-Knowledge: Understanding of BMI as a diagnostic measure, principles of energy balance, and treatment options for obesity.

-Attitudes: Perceived barriers to obesity management and self-confidence in managing obesity.

-Demographics: Gender, academic year, and geographic region.

Statistical analysis

Statistical analyses were conducted using RStudio (version 4.3.1, R Foundation for Statistical Computing, Vienna, Austria) [27]. Categorical variables were summarized as frequencies and percentages. Associations between knowledge items and participant characteristics were evaluated using Fisher's exact test or Pearson's chi-square test, as appropriate. Relationships between knowledge scores and factors such as gender were analyzed using the Wilcoxon rank-sum test. At the same time, comparisons across regions and academic years

employed the Kruskal-Wallis rank-sum test. Statistical significance was determined at a threshold of $p < 0.05$.

Ethical considerations

Ethical approval was secured from the Institutional Review Board (IRB) of King Abdullah International Medical Research Center (KAIMRC) (IRB approval number: IRB/0528/24). Written informed consent was obtained from all participants, and confidentiality was rigorously maintained throughout the study process.

Results

Demographic and academic characteristics of students

Of the targeted 300 participants, 225 completed questionnaires were included in the final analysis, corresponding to a 75.0% completion rate and exceeding the minimum required sample size of 222. The majority were female (77.8%), while males accounted for a smaller proportion (22.2%). Among the students, the highest representation was observed among sixth-year students (74.7%). Furthermore, the majority of respondents were from Riyadh (41.8%), followed by Jeddah (35.1%) and Hail (23.1%). (Table 1).

Participants' responses to knowledge questions

In assessing participants' knowledge, notable trends emerged across the questions. Regarding the characterization of obesity, a small proportion of students correctly identified a higher total energy expenditure (TEE) as characteristic (16.0%). Notably, respondents also demonstrated understanding of the significance of fat-free mass (FFM) for resting metabolic rate (RMR), with 26.2% selecting the correct option. In terms of identifying the main reason for the increase in overweight and obesity, a significant majority recognized the role of genetic predisposition in addition to inactivity and overabundance of food (76.4%). Similarly, when considering long-term weight reduction, half of the participants correctly identified that any diet could lead to the same weight reduction given equal negative energy balance and long-term compliance (48.0%). Additionally, in selecting the most appropriate recommendation for conservative treatment of obesity, 36.0% of respondents correctly identified a negative energy deficit of approximately 600 kcal/day. Moreover, regarding the diagnostic criterion for obesity, the current standard of BMI (kg/m^2) was accurately identified by 83.1% of participants. Overall performance across key obesity knowledge items is illustrated in Figure 1, while the full item-level responses are presented in Table S1 in the supplementary materials.

Regarding other attitude and perception items, among possible reasons for resistance to initiating obesity treatment, the most agreed-upon factor was the belief that long-term follow-up and frequent consultations were beyond capacity in a busy clinical setting (40.4%). Similarly, in reflecting on their role as medical professionals treating patients with obesity, a notable proportion expressed confidence in their university education and in their ability to treat such patients (34.2%, Table S1 in the supplementary materials).

Table 1. *Demographic and academic characteristics of students.*

Characteristic	*N* = 225
Gender	
Male	50 (22.2%)
Female	175 (77.8%)
Year of study	
Third	24 (10.7%)
Fourth	15 (6.7%)
Fifth	18 (8.0%)
Sixth	168 (74.7%)
Region	
Jeddah	79 (35.1%)
Hail	52 (23.1%)
Riyadh	94 (41.8%)

Data are presented as *n* (%).

Differences in knowledge based on participants' gender

A higher proportion of females correctly identified a lower TEE as characteristic of people with obesity compared to males ($p = 0.021$). Conversely, when identifying the level of PA recommended for individuals with obesity to maintain WL, a significantly higher proportion of males recommended 45-60 min/day of moderate-intensity activity than females ($p = 0.008$; Table S1 in the supplementary materials).

Differences in knowledge based on participants' year of study

Notably, there was a significant difference in the proportion of respondents who correctly identified BMI as the current standard diagnostic criterion for obesity, with a higher percentage of respondents in the fifth year (72.2%) and the sixth year (88.1%) compared to the third year (66.7%) and the fourth year (66.7%) ($p = 0.004$). In response to the question regarding TEE and RMR, there was a significant difference in the proportion of respondents who correctly identified the importance of FFM for RMR, with a lower percentage of respondents in the third year (16.7%), fourth year (13.3%), and sixth year (28.0%) compared to the fifth year (33.3%, $p = 0.031$). Another significant difference was found in the tool considered best for diagnosing obesity in children, where the use of iso-BMI curve was favored by a significantly higher percentage of respondents in the third year (12.5%) and fourth year (13.3%) compared to the fifth year (0%) and sixth year (3.0%) ($p < 0.001$). Additionally, a significant difference was observed in the recommendation for PA level to maintain WL, with a higher proportion of respondents in the third year (54.2%) recommending 45-60 min/day of moderate intensity compared to the fourth year (53.3%), fifth year (38.9%), and sixth year (19.0%, $p < 0.001$). Moreover,

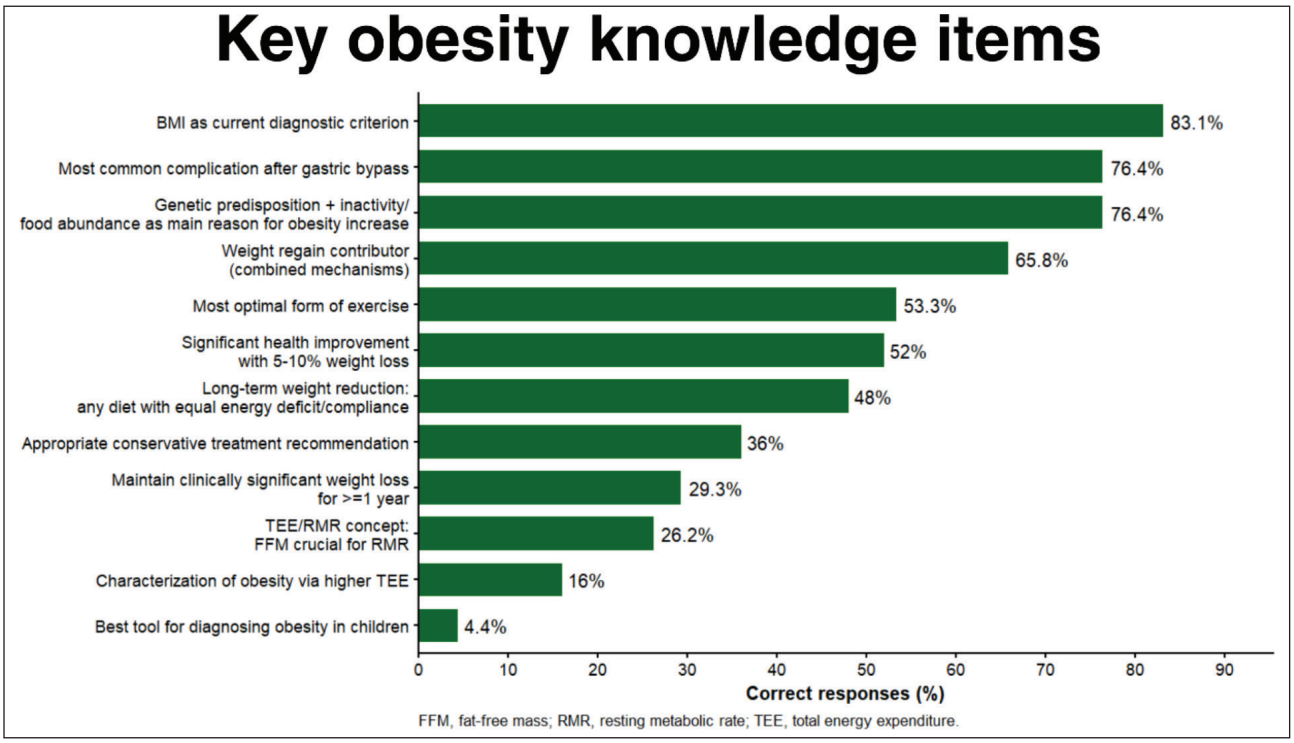


Figure 1. *Percentage of participants selecting the correct response across key obesity knowledge items.*

regarding the long-term outcomes of bariatric surgery, a higher percentage of respondents in the third year (50.0%), fourth year (60.0%) and fifth year (50.0%) correctly identified that approximately 15% of patients experience suboptimal WL or significant weight regain after gastric bypass surgery, compared to the sixth year (26.8%, $p = 0.023$). In terms of complications after gastric bypass surgery, a significantly lower proportion of respondents in the third year (50.0%), fourth year (60.0%), and fifth year (66.7%) correctly identified low levels of vitamin B12, vitamin D, calcium, and iron as the most common complication compared to the sixth year (82.7%, $p = 0.002$) Year-of-study differences in correct responses across obesity knowledge items are summarized in Figure 2, while the complete item-level responses are presented in Table S2 in the supplementary materials.

Differences in knowledge based on participants' city

Significant city-based differences were observed in participants' responses to certain knowledge items. For instance, regarding the best characterization of people with obesity compared to normal-weight individuals, a significantly higher proportion of respondents in Riyadh (24.5%) reported higher TEE than those in Jeddah (7.6%) and Hail (13.5%; $p < 0.001$). Regarding the correct understanding of TEE and RMR, a significantly higher proportion of respondents in Riyadh (29.8%) correctly identified that the degree of FFM is crucial for RMR compared to those in Jeddah (22.8%) and Hail (25.0%) ($p = 0.021$). Furthermore, concerning the main reason for an increase in overweight and obesity, a significantly higher proportion of respondents in Jeddah (79.7%) and Riyadh (81.9%) correctly indicated that a genetic predisposition, in addition to inactivity and overabundance of food, is the main reason, compared to those in Hail (61.5%, $p = 0.023$). Additionally, in terms of the most likely contributor to weight gain after a period of WL, a significantly higher proportion of respondents in Jeddah (69.6%) correctly chose the combination of reduction in motivation, RMR, and a decrease in energy expenditure related to PA compared to those in Hail (59.6%) and Riyadh (66.0%, $p = 0.035$). Significant regional disparities were noted in participants' responses to the question about the best tool for diagnosing obesity in children ($p = 0.048$). A significantly higher proportion of respondents in Jeddah (63.3%) and Riyadh (68.1%) correctly identified the Iso-BMI curve as the preferred tool compared to those in Hail (44.2%).

Regarding the most effective diet for long-term weight reduction, a substantial majority in Jeddah (49.4%) and Riyadh (61.7%) believed that any diet could yield similar weight reduction with equal negative energy balance and long-term compliance, whereas a smaller proportion in Hail (21.2%) held this view ($p < 0.001$). In terms of long-term outcomes of bariatric surgery, a significantly higher percentage of respondents in Hail (36.5%) believed that approximately 15% of patients experience suboptimal WL or significant weight regain after gastric bypass surgery, compared to those in Jeddah (30.4%) and Riyadh (34.0%, $p = 0.010$). Moreover, in response to the question about the most common complication after gastric bypass surgery, a larger proportion of respondents in Jeddah (77.2%) and Riyadh (84.0%) identified low levels of vitamin B12, vitamin D, calcium, and iron as the most common complication compared to those in Hail (61.5%, $p = 0.027$). Finally, regarding the condition least

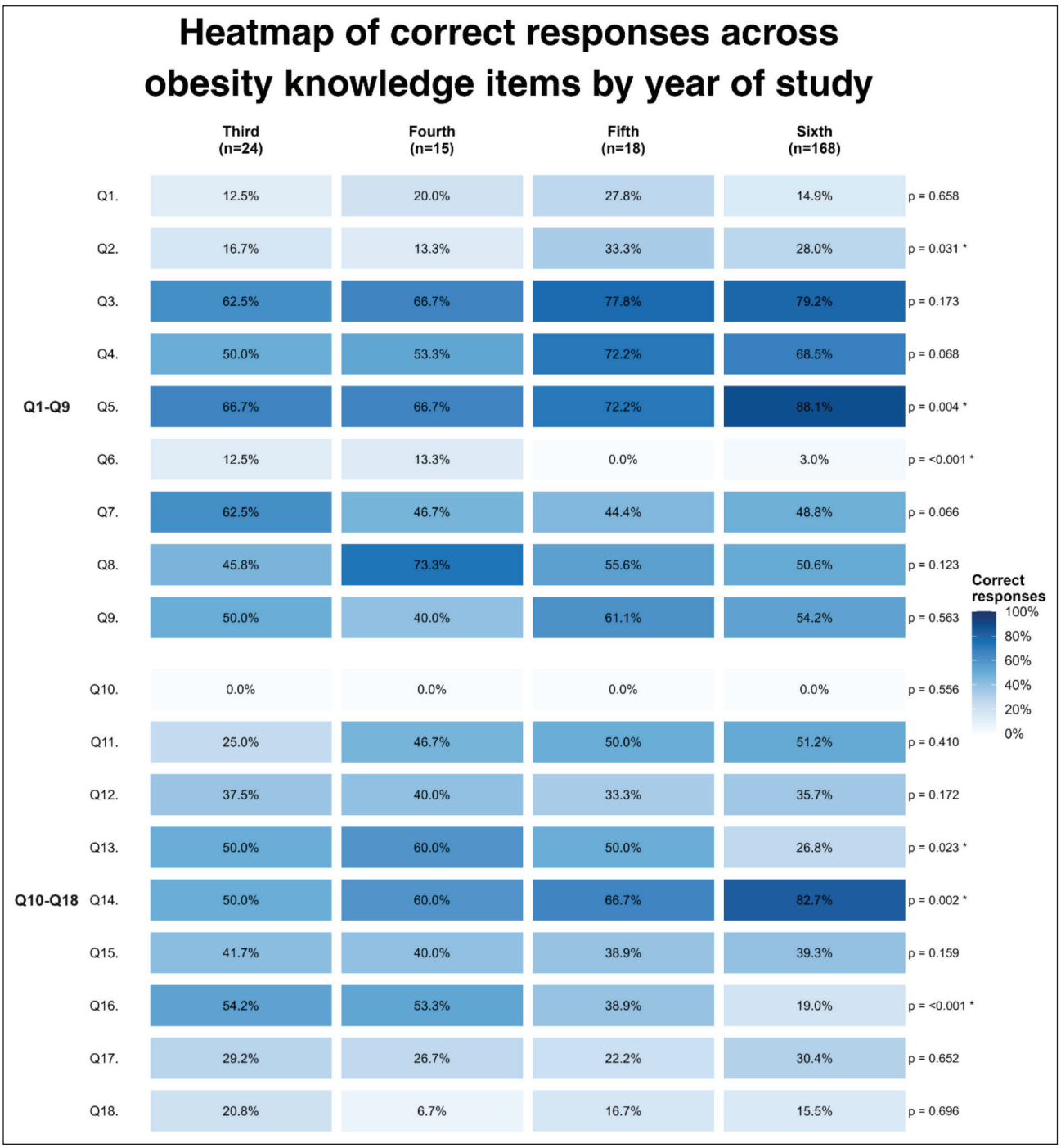


Figure 2. *Percentage of participants selecting the correct response across obesity knowledge items by year of study. Asterisks beside p values indicate statistically significant differences across academic years.*

associated with obesity, a significantly higher percentage of respondents in Riyadh (46.8%) and Hail (42.3%) identified osteoporosis as the least associated condition, compared with those in Jeddah (29.1%; $p = 0.007$; Table S3 in the supplementary materials).

Factors associated with the knowledge score

The distribution of the knowledge score is depicted in Figure 3, indicating that the variable is non-normally distributed. This was confirmed by the Shapiro-Wilk normality test ($p = 0.001$). The median knowledge score for all students was 7.0 (out of 18), and the interquartile range was 6.0 to 9.0. Students reported a minimum of 1.0 and a maximum of 14.0. The knowledge score significantly differed across cities ($p = 0.010$). Participants from Riyadh demonstrated a higher median knowledge score (median = 8.00, IQR = 7.00 to 9.00) compared to those from Jeddah (median = 7.00, IQR = 6.00 to 9.00) and Hail (median = 7.00, IQR = 5.00 to 8.00); this V is shown in Figure 4. However, no significant differences were observed by gender ($p = 0.611$) or year of study ($p = 0.503$; Table 2).

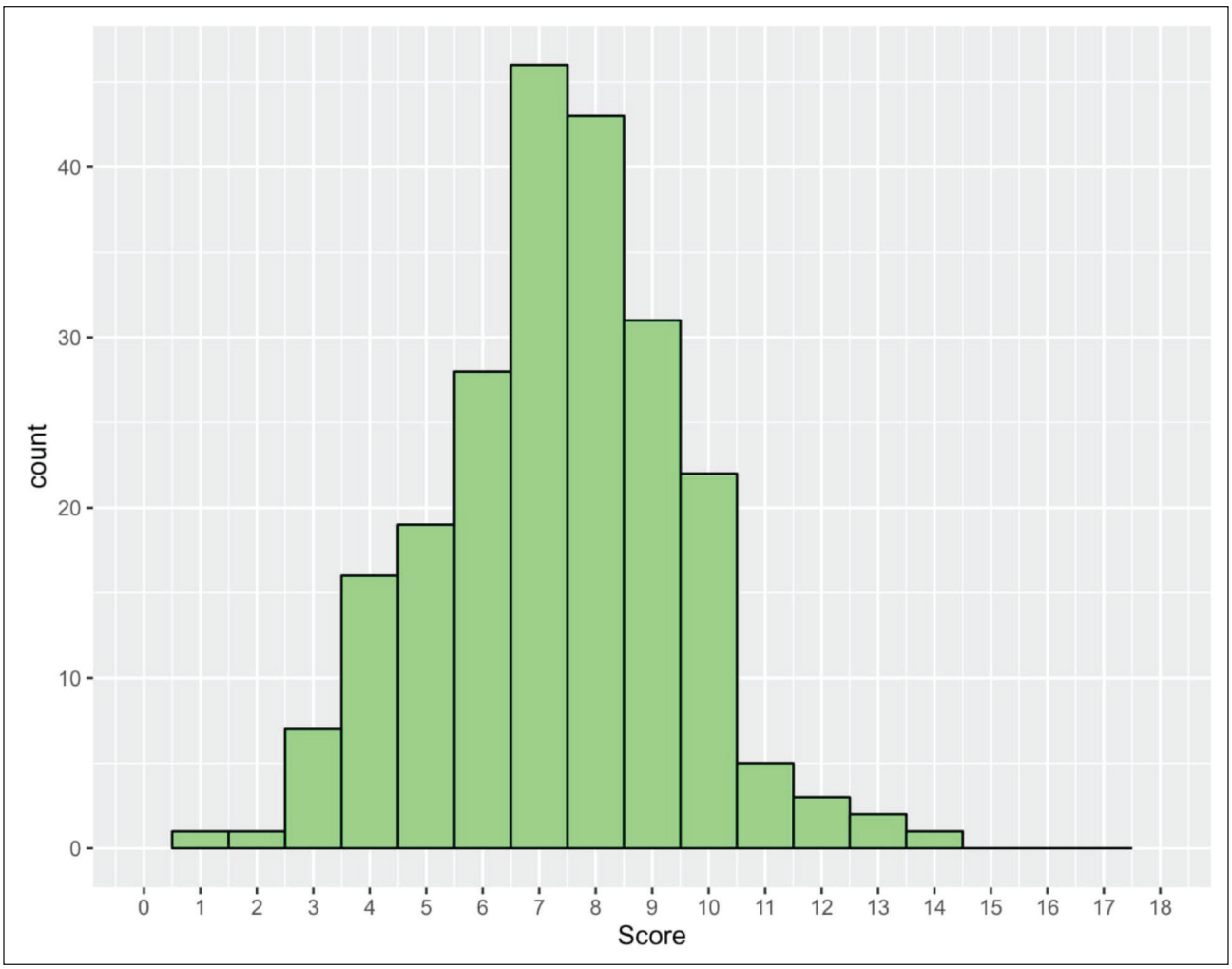


Figure 3. *Distribution of the total knowledge score among participating medical students (N = 225).*

Discussion

This research highlights significant gaps in medical students' knowledge of obesity in Saudi Arabia, particularly regarding advanced treatment strategies and long-term patient outcomes. More specifically, although most participants correctly identified BMI as the standard diagnostic criterion for obesity, weaker performance was observed for metabolic concepts, conservative treatment recommendations, and knowledge related to bariatric surgery, while knowledge scores also differed significantly by city. While most participants correctly identified BMI as a diagnostic measure, their understanding of metabolic concepts such as TEE and FFM was limited. Similar deficiencies in obesity education have been reported globally [25,26].

This interpretation is supported by broader curriculum data. Metcalf et al. reported that both medical students and faculty perceived important gaps in obesity medicine teaching and identified a need to supplement existing curricula [28]. In line with findings from Martins and Norsett-Carr [26], senior students displayed a higher level of knowledge than their junior peers. However, substantial weaknesses remained evident even among senior students, especially concerning surgical complications and long-term effectiveness. This indicates a pressing need for more comprehensive and ongoing educational efforts throughout medical training. However, not all findings are identical. In a recent Saudi study from Qassim University, most medical students demonstrated high obesity knowledge and moderate attitudes, but poor practice, suggesting that factual knowledge alone may not translate into effective obesity-management behaviors [29].

Recent intervention studies further strengthen this interpretation. Olson et al. [30] showed that implementation of a structured preclinical obesity curriculum improved first-year medical students' self-reported knowledge and attitudes toward obesity. Similarly, Özgüç et al. [31] found that students exposed to a distinct bariatric and metabolic surgery education program had better knowledge and more appropriate referral-related responses than those without such training.

Gender and geographic disparities further underscore unevenness in obesity education. Female students performed better in specific areas than male students. At the same time, those studying in Riyadh demonstrated greater knowledge than their counterparts in Jeddah and Hail. These discrepancies may stem from differences in

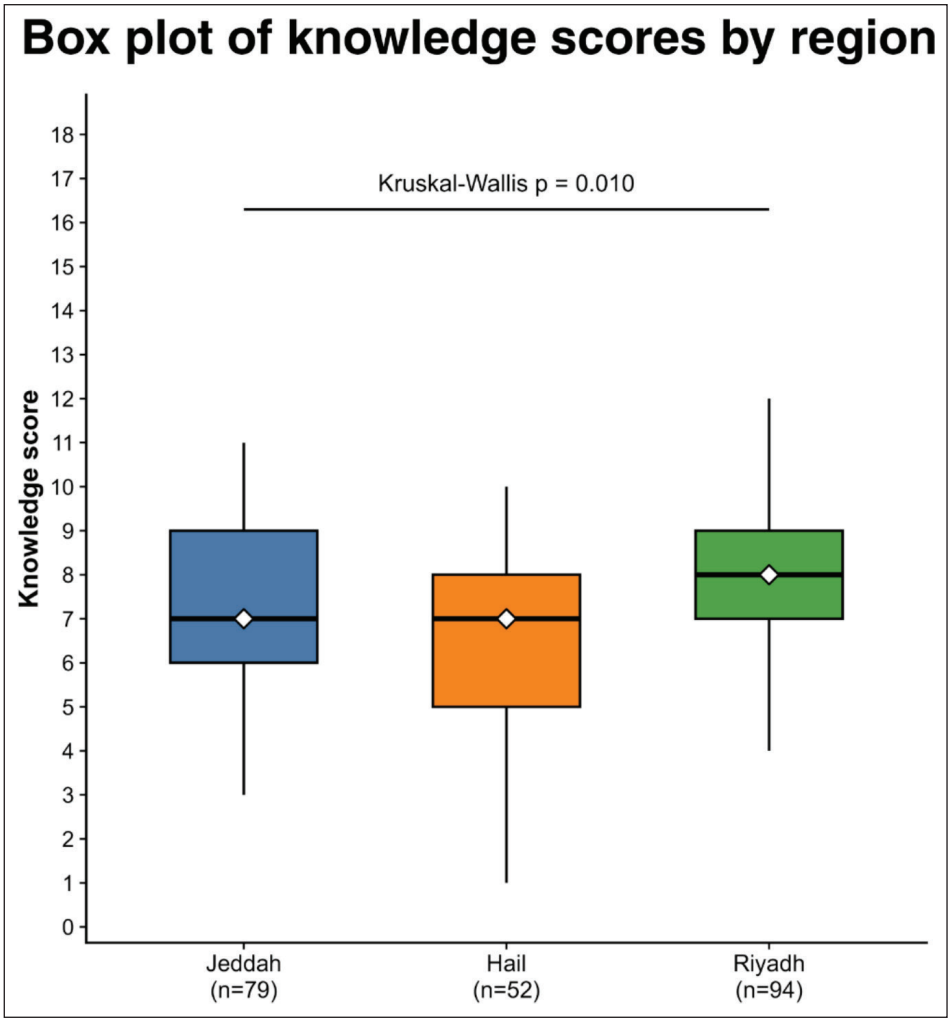


Figure 4. *Distribution of knowledge scores by city. Center line indicates the median; box limits indicate the interquartile range; whiskers represent 1.5 × IQR.*

curriculum design, access to educational resources, or faculty expertise across various institutions [22,25].

Challenges to effective obesity management were also noted, including insufficient clinical exposure and low confidence levels among students. These challenges are not limited to knowledge alone, as prior literature has also documented attitudinal barriers. Pantenburg et al. [32] reported prevalent stigmatizing attitudes toward patients with overweight and obesity among German medical students, emphasizing the need to address obesity as a complex, multifactorial disease within medical training. Encouragingly, Trofymenko et al. [33] demonstrated that a brief multi-modality educational intervention significantly reduced explicit anti-obesity bias among first-year medical students, indicating that targeted teaching can improve the attitudinal dimension of obesity care as well. These findings align with previous studies emphasizing the importance of hands-on learning and practical experience in developing clinical competence [25]. To address these challenges, curricular improvements and standardized educational approaches focused on obesity are essential. One recommendation is to implement Clinical Reasoning Exams (CREs) within pertinent clinical-phase modules to enhance students' comprehension and practical application of obesity management knowledge. This educational strategy has the potential to significantly enhance the preparedness of future healthcare professionals in managing obesity.

Strengths and limitations

This study has several strengths. It involved medical students from several medical institutions in three geographically disparate Saudi cities and used a validated questionnaire to assess knowledge, attitudes, and perceptions regarding obesity management. In addition, the study analyzed differences by academic year, gender, and city, providing a broader picture of variation in medical students' knowledge of obesity. However, several limitations should be recognized. A cross-sectional design limits causal inference, and the use of self-administered electronic responses may have introduced response and social desirability bias. The sample was also unevenly distributed (with a predominance of female and sixth-year students), which may have implications for generalizability. Furthermore, the study was limited in scope to selected cities and relied on questionnaire-based evaluation rather than actual assessment of clinical competence. Finally, the bariatric

Table 2. *Factors associated with the knowledge score based on the demographic characteristics.*

Characteristic	*N* = 225	*p*-value
Gender		0.611
Male	7.00 (6.00, 8.00)	
Female	7.00 (6.00, 9.00)	
Year of study		0.503
Third	6.50 (5.00, 8.00)	
Fourth	7.00 (6.00, 8.00)	
Fifth	7.00 (6.25, 9.00)	
Sixth	8.00 (6.00, 9.00)	
Region		0.010
Jeddah	7.00 (6.00, 9.00)	
Hail	7.00 (5.00, 8.00)	
Riyadh	8.00 (7.00, 9.00)	

Score: Median (IQR), Wilcoxon rank sum test; Kruskal-Wallis rank sum test.

surgery component was relatively small and warrants further investigation in future studies.

Implications and recommendations

Based on these findings, we propose incorporating a more standardized, long-term approach to obesity management into the medical school curriculum in Saudi Arabia, balancing lifestyle, pharmacological, and surgical approaches. Curriculum development should focus more on clinical exposure, case-based learning, and practical forms of assessment, such as the CREs, to increase students' confidence and competence in obesity management. At the policy level, national recommendations for core competencies in obesity management for undergraduate medical education may help to reduce regional variation in training. Future research should incorporate larger, more representative, multicenter samples, a more balanced distribution across academic years and gender, objective measures of clinical preparedness, and assessments beyond knowledge-based ones.

Conclusion

Despite a reasonable foundational understanding of obesity, substantial educational gaps remain in advanced management techniques among Saudi medical students. Notably, the assessment of bariatric surgery knowledge in this study was limited, highlighting a need for more comprehensive evaluation and education on surgical management in future research and curricula. It is crucial to enhance medical school curricula to provide consistent, thorough instruction on obesity, equipping future healthcare professionals with the skills to tackle this growing public health concern effectively.

List of Abbreviations

BMI Body mass index
CBT Cognitive behavioral therapy
CREs Clinical reasoning exams
FFM Fat-free mass
GBP Gastric bypass
HIIT High-intensity interval training
IRB Institutional Review Board
KAIMRC King Abdullah International Medical Research Center
LCHF Low carbohydrate–high fat
NAFLD Non-alcoholic fatty liver disease
OSAS Obstructive sleep apnea syndrome
PA Physical activity
PALs Physical activity levels
RMR Resting metabolic rate
TEE Total energy expenditure
VAT Visceral adipose tissue
WHO World Health Organization
WL Weight loss.

Conflicts of interest

The authors declare that they have no conflict of interest regarding the publication of this article.

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Consent to participate

NA.

Ethical approval

NA.

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Supplementary content (If any) is available online.

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