Learning Styles of Medical Students: A Systematic Review

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Abstract

Background: Knowledge of the learning style of students allows educational methods to be adapted with their learning style and leads to higher educational efficiency. The present study reviews and compares published articles on the learning styles of medical students worldwide using the VARK or Kolb's questionnaires.

Materials and Methods: In this systematic review, a systemic search of online databases (Medline, EMBASE, Scopus, Web of Science, Cochrane Library, CIVILICA, and Google Scholar search engine) was conducted for related studies using VARK or Kolb inventories and related Mesh keywords with no time limit up to December 2021. Two reviewers evaluated the quality of eligible studies and carried out the selection procedure.

Results: A total of 34 studies from 14 countries assessing the learning style of 6,161 medical students were included. There was a variation in learning style preference among preclinical and clinical students based on gender and educational levels (P<0.05). Based on Kolb's learning style inventory (874/6,161), a majority of students had the accommodator learning style (54.6%), while convergers (52%), assimilators (47%), and divergers (19.7%) were fewer. Based on the VARK inventory, the students' preference towards multimodal learning style (bimodal) across worldwide studies ranged from 13.2% (Saudi Arabia) to 87% (Iran), with 70% being kinesthetic. Among the unimodal learning preferences, kinesthetic (69.2%), and auditory (55.9%) were the most preferred.

Conclusion: Medical students have different learning styles, and faculty members must pay attention to this issue and use different and innovative teaching methods.

Key Words: Learning Style, Medical Students, VARK inventory, Kolb learning style inventory.

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1- INTRODUCTION

Professors, especially in academia, must know the content, education, and the learner and their characteristics to teach effectively (1). Many faculty members of universities have sufficient knowledge of the content of their specialized courses, obtained through continuous study and practice in their teaching area. Many also have knowledge related to the principles of education, which is also the result of studying classic texts on education and participating in relevant empowerment courses and workshops. However, gaining knowledge about the learner and their characteristics is, unfortunately, often considered trivial to improving classroom instruction (1, 2). The fact that some learners do not learn well despite having the best teachers is evidence that learners have different learning preferences (3). Learners acquire and process information in various ways according to their characteristics; seeing and hearing, reflection and action, thinking, analysis, and perception (4). Experts believe that although students have different learning styles, the teaching method generally relies on lecturing (5). Learning outcomes will improve if the teaching is adjusted with the learning styles of students (6, 7). Learning style consists of the methods and conditions with which learners perceive, process, store, and recall what they learn more efficiently and effectively (8). According to Kolb, learning in adults is the process of acquiring knowledge through the transformation of experiences. He defines learning as a four-step process: following tangible and objective experience, reflection and observation occur, leading then to the formation of abstract concepts, and finally, those concepts are evaluated through active experimentation (9). In this process, a learning style is a personal approach to receiving and processing information that is created by genetic characteristics and individual experiences with environmental expectations (10). The Kolb Learning Style List classifies learners into four main learning styles: Convergent, Divergent, Assimilator, and Accommodator (**Figure.1**).
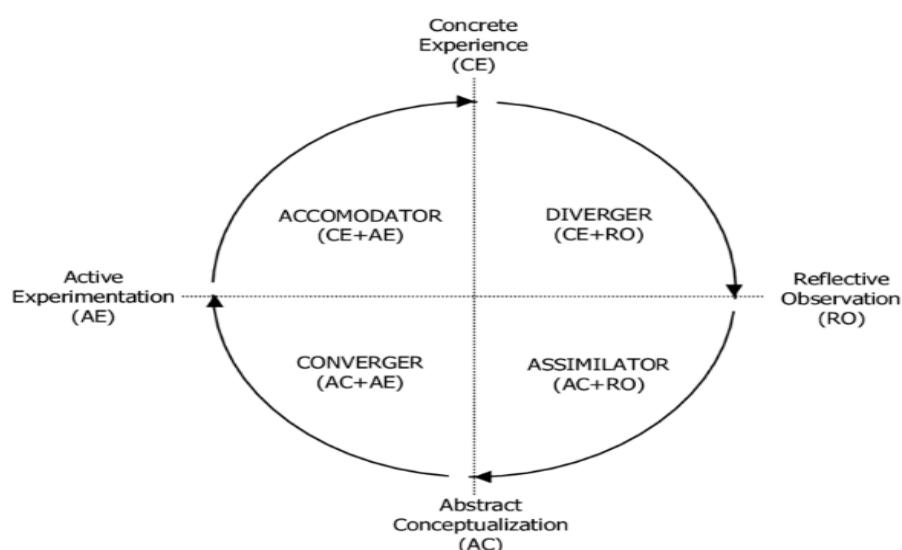

Fig. 1: Kolb's Experiential Learning Model (11).

Kolb's learning styles have the following characteristics:

1. Diverging (concrete experience/reflective observation)

This learning style has an original and creative approach. Rather than examining concrete experiences through actions, individuals tend to assess them from various perspectives. They value feelings and take an interest in others. Those who prefer this learning style tend to enjoy tasks such as brainstorming ideas and working collaboratively in groups. Divergers prefer instructional techniques that involve:

▪ Hands-on activities and the opportunity to explore

▪ Classic teacher-class lecture that highlights how to use a system as well as its strengths and weaknesses.

2. Assimilating (abstract conceptualization/reflective observation)

This learning style emphasizes reasoning. Individuals with this learning style review the facts and assess the experience as a whole. They tend to enjoy designing experiments and working on projects from start to completion.

Assimilators prefer instructional techniques that involve:

▪ Independent, prepared exercises that the learner can complete without the instructor

▪ Classic teacher-class lecture supported by audio or video presentation

▪ Private exploration or demonstration that follows a tutorial, with answers provided.

3. Converging (abstract conceptualization/active experimentation)

This learning style highlights problem solving as the approach to learning.

Individuals with this learning style can make decisions and apply their ideas to new experiences. Unlike Divergers, they tend to avoid people and perceptions, choosing instead to find technical solutions. Convergers prefer instructional techniques that involve:

▪ Workbooks or worksheets that provide problems sets

▪ Computer-based tasks

▪ Interactive activities.

4. Accommodating (concrete experience/active experimentation)

This learning style is adaptable and intuitive. Individuals with this style use trial and error to guide their experiences, preferring to discover the answers for themselves. They can alter their path based on the circumstance and generally are good at dealing with people. Accommodators prefer instructional techniques that involve:

▪ Activities that allow them to be actively engaged

▪ Exploration and instructor support for deeper questioning, such as "what if?" or "why not?"

▪ Tasks that promote independent discovery (9-11).

Another tool for measuring the learning style is the VARK Learning Styles Questionnaire, developed by Lincoln University in New Zealand in 1998. In the VARK (Visual, Aural, Read/Write, and Kinesthetic) model, the students' learning styles are dependent on how they prefer to perceive/receive information. They may prefer a single mode (unimodal), two modes (bimodal), three modes (trimodal), or all four modes (quadrimodal) of the information presentation (**Figure.2**). VARK questionnaire is a versatile, free, and easy to administer tool that encourages students to study with different learning techniques to perform well. In this model,

students are divided based on their abilities into subgroups: people with strong visual function (visual style), people with strong reading and writing performance (reading and writing style), people with strong hearing function (auditory style), people with strong skill performance (kinetic style), and people with multiple performances, who use two or more abilities at the same time in learning. The styles in this tool are: visual, in which learners learn better by seeing and presenting information better, aural (listening), where learners learn better through listening and oral instruction, read-write, in which learners learn better by taking notes and reading written or printed texts, and kinesthetic style, where learners learn by doing practical, experimental examples and manipulating objects in a better physical process. The advantage of the VARK learning style is that it provides information about learning strategies and teaching methods and media appropriate to these styles (12).
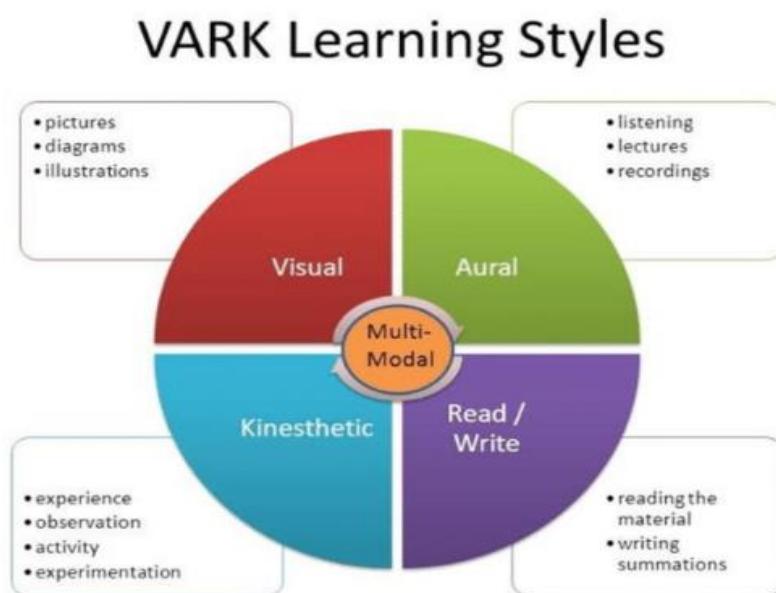
Fig. 2: VARK Learning Styles (12).

Medical students, due to the nature of the field and the professional importance of their job, need a special type of practical training, and the professors should use different methods and media for teaching. The choice of these methods and educational media, both in traditional and virtual education, depends on various factors, such as students' learning styles. Knowledge of learning styles can help develop more effective educational approaches. Identifying learning preferences and teaching based on them has been found useful in several studies (8, 13-15).

2- MATERIALS AND METHODS

The Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) checklist was used as the template for this review (16).

2-1. Eligibility criteria

Participants, interventions, comparators, and outcome (PICO) was used to formulate the review objective and inclusion criteria.

2-1-1. Participants: Medical students worldwide.

2-1-2. Interventions: The included research are non- interventional studies, so we did not have comparison group.

2-1-3. Comparators: We did not have a comparison group and intervention.

2-1-4. Outcomes: Learning styles.

2-2. Included studies: Case-control studies, cross-sectional studies, qualitative studies, and descriptive and analytical studies were included in the study. The inclusion criteria were the focus on learning styles of medical students, being published up to December 2021, written in English or Persian, and published articles with full-text available.

2-3. Exclusion criteria: The exclusion criteria were abstracts not linked to the full article, articles not written in English or Persian, reviews or meta-analyses, pilots, preliminary, letters to the editor, editorials, short reports, case reports, and briefs.

2-4. Information sources

A systemic search of electronic databases Medline (via PubMed), EMBASE, Scopus, Web of Science, Cochrane Library, CIVILICA, and Google Scholar search engine was conducted. The search was done independently and in duplication by two reviewers, and any disagreement between the reviews was dissolved by the supervisor.

2-5. Search

Search words were a combination of (Learning Style OR Learning) AND (VARK inventory OR Kolb inventory) AND (Undergraduate Students OR Medical Students OR Preclinical Students OR Clinical Students).

2-6. Study selection

Database search was done for possible studies, study abstracts were screened for eligible studies, full-text articles were obtained and assessed, and a final list of included studies was made. This process was done independently and in duplication by two reviewers, and any disagreement was resolved by the third reviewer. References were organized and managed using EndNote software (version X8).

2-7. Data collection process

A researcher form was developed and followed for each study. Two reviewers collected the data independently. The collected data were combined and compared for accuracy, and a third reviewer solved any discrepancies.

2-8. Risk of bias in individual studies

The risk of bias was assessed based on the Cochrane Risk of Bias criteria (17) by two reviewers independently and in duplication, and any discrepancies were resolved by a third reviewer.

2-9. Synthesis of results

Due to the difference in the included studies, study designs, small sample size, and type of questionnaire used, meta-analysis was not conducted.

3- RESULTS

Finally, 14 studies from 14 countries were included in this systematic review (n=6,161). Of these, five studies (n=874) used the Kolb LSI, and nine studies used the VARK inventory (n=5287). Based on the results, there are diverse learning styles at preclinical and clinical levels of medical students. The main characteristics of the selected studies are summarized in the following:

1. Iran

1. A cross-sectional study on 71 medical students at the Isfahan University of Medical Sciences using the VARK questionnaire showed that medical students use different learning styles. The preferred learning style of most students was the visual style. Male and female students had different learning styles. The

mean of dominant style in female students was reading-writing style and in male students was the listening style (p> 0.05) (18).

2. A cross-sectional study on 221 medical students assessed the learning style of pre-clinical medical students at Tehran University of Medical Sciences using a questionnaire (Kolb-LSI) in 2011-2012. The results showed that the most prevalent learning styles among students were convergent (34.4), and adaptive (30.8). Also, students' learning styles in basic sciences and clinical sciences had a significant difference (19).

3. A cross-sectional study was conducted on 175 medical students in 2008-2009 to identify the learning styles of medical students of Birjand University of Medical Sciences using a questionnaire (Kolb). The results showed that the most prevalent student learning styles were convergent (52%), absorbing (28.6%), divergent (9.7%), and adaptive (9.7%). There was no significant relationship between the learning style and the variables of age, gender, level of education, and grade point average of students (20).

4. A cross-sectional survey on 225 medical students in 2018-19 compared the learning style of Iranian and international medical students of Tehran University of Medical Sciences using the VARK questionnaire. The results showed that the kinesthetic (p<0.05), and aural (P<0.05) styles were significantly different. The results represented the prevalence of the bimodal learning style among Iranian and international students (87%) compared to tri- and quadmodal styles (21).

5. A descriptive-analytical study on 111 first-year medical students of the Shahid Beheshti University of Medical Sciences aimed to determine their learning style using the VARK questionnaire in 2018. The results showed that most students had a multimodal learning style (52%),

although no significant difference was observed between preferring single- and multimodal styles. Among the multimodal learning styles, the bimodal style was more prevalent among subjects (21.62%). Aural and visual learning styles were determined as the most (20, 37.74%), and least (8, 15.09%) preferred styles by students, respectively (22).

2. Pakistan

1. A cross-sectional study was conducted on 65 fourth-year medical students of Gujranwala Medical College, Punjab, Pakistan. The study assessed the learning styles of undergraduate medical students and the effect of preferred style on gender and academic performance of students using the VARK Questionnaire. The results showed that 38.5% of students prefer the unimodal learning style. The rest (61.1%) were in favor of using more than one learning style to perform. It was also found that male and female students both perform well irrespective of the adopted learning style (23).

2. A cross-sectional survey on 338 medical students aimed to determine the learning styles of undergraduate medical students using an online VARK inventory. The results showed that most students favored a multimodal learning style (69%). The preferred unimodal styles were aural (14%) and kinesthetic (12%). In different combinations, the favored learning modes were kinesthetic (70%), reading/writing (60%), aural (57%), and visual (55%) styles. The preference for multiple learning modes increased with the transition from pre-clinical first-and second-years to the clinical third- and fourth-year students (p=0.006) (24).

3. A cross-sectional study on 597 medical students from six medical colleges assessed the preferred learning styles and determined their association with the academic performance of undergraduate medical students using the VARK

questionnaire (version 7.0). The results showed that the mean scores for VARK styles were 4.28 ± 0.09, 4.91 ± 0.08, 4.54 ± 0.07, and 4.75 ± 0.09, respectively. A total of 27.6% of students preferred a unimodal learning style, and 72.4% of students preferred multiple learning styles. It showed that the majority of students preferred a multimodal learning style, and the learning style preference is not associated with academic performance in medical students across Pakistan (25).

4. A cross-sectional descriptive study on 152 medical students in clinical classes of the Islamic International Medical College (IIMC) in Pakistan aimed to determine the learning styles of medical students using Kolb's learning style. The results showed that the majority of students had the accommodator learning style (n=83, 54.6%), while convergers (21%), divergers (13.2%), and assimilators (10.5%) were fewer in number (26).

5. A cross-sectional study on 122 medical students aimed to determine the learning styles of third-year medical students in Sheikh Zayed Medical College Rahim Yar Khan using Kolb's Learning Style Inventory. The results showed that the dominant learning style among third-year medical students was the convergent learning style, as 42 out of 122 (34.4%) students opted for it. The second, third, and fourth preferred learning styles were accommodative with 33 (27%), assimilative with 25 (20.5%), and divergent with 24 (19.7%) students (27).

3. Malaysia

1. A descriptive cross-sectional study on 239 first- to fifth-year medical students in 2015 aimed to identify the learning style preference in Malaysian medical universities using the VARK questionnaire (version 7.8). The results showed that the majority (53.61%) of preclinical students preferred a unimodal learning style. A total of 46.39% of clinical students had the highest preference towards multimodal learning style. From the unimodal styles, kinesthetic mode (69.2%) has the highest prevalence among preclinical students, followed by reading/writing, visual, and aural styles. In this study, both male and female students showed a similar preference (51.5% male and 51.7% female) for the multimodal learning style (28).

4. Sri Lanka

1. A study was conducted on 147 medical undergraduates of the University of Colombo and postgraduate trainees of the Postgraduate Institute of Medicine, Colombo. The study aimed to test the hypothesis that learning styles and approaches to learning differ among first- and final-year undergraduate medical students and postgraduate medical trainees using VARK and ASSIST questionnaires. The results showed that the majority (69.9%) of first-year students had a multimodal learning style. Among final year students, the majority (67.5%) had a multimodal learning style. Among postgraduates, the majority were unimodal (52.9%) learners, with 33.4% having the kinesthetic style ($p = 0.019$) (29).

5. India

1. A cross-sectional study on 100 first-semester medical students aimed to determine the preferred learning styles of medical students as well as their preferences of teaching-learning methods using the VARK questionnaire (version 7.1). The results showed that the majority (61%) of the students had multimodal VARK preferences, indicating that they preferred multiple modes of information presentation. Among them, 41%, 14%, and 6% preferred the bimodal, trimodal, and quadrimodal ways of information presentation. A total of 39% of the respondents had one strong (unimodal) learning preference. The most common

unimodal preference was kinesthetic, followed by visual, auditory, and reading/writing. The most preferred teaching methodology was practical/dissection (39%), and tutorial was the least preferred one (12%) (30).

2. A study on 121 second-year MBBS students aimed to study the distribution of diverse learning styles and the predominant learning approach among the medical students using the VARK questionnaire (version 7.8). The results showed that 53.8% of students were unimodal, and 46.2% were multimodal learners. Among the unimodal learners, visual learners were the most prevalent (24.1%). There was no significant association between gender and learning style preferences among medical students. Females were predominantly visual learners, whereas kinesthetic learners were more among males (p>0.05) (31).

3. A cross-sectional study among 147 medical students in 2016-17 aimed to determine the sensory modality learning preferences of first-year medical students at Mahavir Institute of Medical Sciences, Vikarabad, Telangana State, India, using the VARK questionnaire (version 7.8). The results showed that the majority of first-year medical students (118, 80.27%) preferred a single (unimodal) sensory modality for learning. It was also found that 47% had a preference for the kinesthetic (K) modality, and 30% had a preference for the visual (V) modality, followed by 14% for auditory (A) and 9% for reading/writing (R). Also, 29 students (19.73%) preferred multiple learning styles (multimodal). Therefore, the majority of first-year medical students preferred using a single sensory modality while learning (unimodal) (32).

4. In a study on 144 first-year undergraduate students in a tertiary care teaching hospital, the learning style preferences were assessed using the VARK questionnaire. The results showed that the unimodal learning style was preferred by 48% of the students and multimodal learning styles by 52% of students. Among the unimodal learning preferences, kinesthetic (35%), and auditory (34%) were the most preferred among the students. In bimodal preferences, a combination of auditory and kinesthetic approaches was used the most (57%). In trimodal preferences, a combination of visual, auditory, and kinesthetic approaches was used the most (71%). There was no difference in the learning preferences between genders (p=0.208) (33).

5. A study on 203 medical students from pre- and para-clinical phases aimed to investigate gender preferences and variations in the learning style among pre- and para-clinical students in a medical college using the VARK questionnaire. The results showed that most students preferred a multimodal learning style. Para-clinical students leaned significantly more towards multimodal and less toward kinesthetic (K) unimodality compared to pre-clinical students. Similarly, most males were multimodal, and the aural (A) unimodality was significantly more prevalent among females. Also, 27% of students from the pre-clinical phase and 47% of students in the para-clinical phase were multimodal (34).

6. Barbados

1. A study on 157 pre-clinical students in 2014 aimed to assess learning style preferences using the VARK questionnaire. The results showed that the majority of students were multimodal learners (59.5% males and 60% females). The most common learning style for this group of medical students was reading/writing (33.8%), followed closely by kinesthetic (32.5%) learners. A higher proportion of males (40.5%) than females

(30%) were kinesthetic learners (p>0.05) (35).

7. Oman

1. A descriptive, cross-sectional study on 140 students aimed to assess the learning preferences of students in the pre-clinical years of the medical degree program at Oman Medical College, Sohar, using the VARK questionnaire. The results showed that 35% of the respondents expressed a preference for a single mode of learning, either visual (8%), auditory (9%), reading/writing (9%), or kinesthetic (9%). The remaining 65% preferred using two (14%), three (19%), or four (32%) modes to assimilate information and were multimodal learners (36).

8. USA

1. A study on 74 students aimed to evaluate the learning style of first-year medical students using the VARK questionnaire. The results showed that two groups of regular admission students and alternate list students had significant differences in the multimodal learning style and visual learning and kinesthetic learning styles (37).

2. A study on 166 first-year medical students in 2005 at Wayne State University School of Medicine investigated their preferred modes of information presentation using the VARK questionnaire. The results showed that 36.1% of the students preferred a single mode of information presentation. Among these, 5.4% preferred the visual mode, 4.8% preferred the auditory mode, 7.8% preferred printed words, and 18.1% preferred using all their senses (kinesthetic). In contrast, most students (63.8%) preferred multiple modes [(two modes (24.5%), three modes (32.1%), or four modes (43.4%)] of information presentation (38).

9. Gambia

1. A cross-sectional on 113 medical students aimed to characterize the learning styles preferred by the students of the School of Medicine and Allied Health Sciences of The Gambia using the VARK questionnaire. The results showed that most students preferred multimodal learning, and the bimodal mode was chosen more frequently. Significant differences were found in kinesthetic scores between pre-clinical and clinical students (p=0.031). In addition, a significant association was indicated with the preferred unimodal variants among pre-clinical and clinical students (39).

10. Colombia

1. A cross-sectional study on 204 first-year medical students at the Pontificia Universidad Javeriana (Bogotá, Colombia) using Kolb's Learning Style Inventory showed that the students preferred the abstract styles of learning, including assimilating (47%), and converging (27%) styles. No statistically significant differences were found in learning modes between genders or semesters (40).

11. Saudi Arabia

1. A cross-sectional on 215 medical students in 2018-19 aimed to investigate the learning styles of undergraduate medical students at the University of Bisha, College of Medicine, using the VARK questionnaire (version 7.1). The results showed that learning styles were categorized into unimodal (86.2%), and multimodal (13.2%) styles. Among unimodal styles (118), the dominant style was aural (55.9%), followed by kinesthetic (32.2), and the least presented was visual (6.8%). All the multimodal patterns were bimodal. Among the multimodal styles (18), the dominant combination was AK (77.8%), followed by VR and VK (11.1%) equally (41).

2. A cross-sectional study on 320 medical students aimed to investigate which

learning styles and approaches are preferred by medical students using VARK questionnaires (version 7.8). The results showed that 53% of students had bimodal learning modalities, 41% preferred unimodal learning, 5% trimodal, and 1% multimodal styles. The majority (46.8%) of the first-year students had unimodal learning styles. Of the second-year students, 17.92% and of the third-year, 15.36% preferred the bimodal style. Among the fourth-year students, 12.8% preferred the bimodal, and the majority of final-year students (13.44%) preferred the multimodal approach (42).

3. A cross-sectional descriptive study on 181 undergraduate students of Majmaah University, College of Medicine, aimed to explore their learning mode preference and its relationship with academic performance using the VARK questionnaire. The results showed that the most common SMP (Sensory Mode Preference) was VARK (51 %), followed by K and A. However, most students perceived their learning style as VK or K. The most common perceived learning mode of male students was AK (audio & kinesthetic = 11.3 %), and VK (visual and kinesthetic, 11.3 %), while females preferred K (28.2 %) (43).

4. A study on 110 medical students (55 students in foundation year (FY) and 55 students in graduation year (GY)) of Inaya Medical College aimed to investigate the learning styles of medical students in Inaya Medical College, Riyadh, using the VARK questionnaire (version 7.0). The results classified the learning styles into unimodal (52.7% for FY students and 70.9% for GY students) and multimodal (the rest). It has been noted that the kinesthetic learning style is the most prevalent among the foundation-year students, where most GY students preferred the aural learning style (44).

5. A comparative study on 207 medical students (preclinical-clinical) aimed to identify and compare students learning styles in basic sciences (first, second and third years) and clinical (4th and 5th years) phase using the VARK questionnaire. The results showed that 72.9% of female and 71.1% of male students preferred to learn via multi-modal (visual, auditory, reading/writing, or kinesthetic). The study showed that 13% of the male students preferred the kinesthetic mode of learning, and 4.1% of female students were tactile learners in the basic sciences phase. Results also showed that 40.67% of the male students in clinical years preferred one mode of learning style, while 44% of female and male students in the basic sciences phase preferred to learn by two modes of learning (45).

6. A cross-sectional study on 146 third-and fourth-year medical students at King Saud Bin Abdul Aziz University for Health Sciences, King Fahad Medical College, aimed to categorize learning preferences of medical students using the VARK questionnaire version (7.0). The results showed that 5.5%, 11.6%, 2.1 %, and 8.2% of students preferred the visual, aural, reading/writing, and kinesthetic modes, respectively. This means that only 27.4% of students preferred to learn by a single sensory modality (visual, auditory, reading/writing, or kinesthetic). Also, 72.6% of students preferred multiple learning styles. Of these, 34.9%, 42.5%, and 22.6% were bimodal, trimodal, and quadmodal, respectively (46).

12. UAE

1. A study on 133 pre-clinical and clinical students in Dubai Medical College aimed to investigate the learning styles of medical students to develop appropriate learning approaches using the VARK questionnaire. The results showed a statistically significant difference between pre-clinical and clinical students in the mean of different VARK styles. The quadmodal preference (VARK) was the

most prevalent, followed by the kinesthetic style. The most common bimodal style was auditory-kinesthetic, and the most common trimodal styles were auditory-reading-kinesthetic and visual-auditory-kinesthetic. There were statistically significant differences between pre-clinical and clinical students in visual-reading preference and auditory-reading-kinesthetic and visual-auditory-kinesthetic preferences (47).

2. A cross-sectional study on 157 pre-clinical students of Gulf Medical University in Ajman, U.A.E., aimed to assess the different learning styles of students and correlate them with the teaching methods using the VARK questionnaire. The results showed that 53.5 % of the participants were multi-modal learners. Kinesthetic learners were more prevalent in older groups (38.l%), and third-year medical students (23.2%), while auditory learners were mostly in lower age groups, first-year (13.5%) and second-year (20%). Of 157 students, 84 were multi-modal, 54 of whom showed preference to lectures and 49 to CBL/PBL/SDL (Case-Based Learning, Problem-Based Learning, and Self-Directed Learning) (48).

13. Egypt

1. A cross-sectional study on 427 undergraduate medical students at Mansoura aimed to identify the main learning style and the effect of sociodemographic characteristics and educational background on learning styles using the VARK questionnaire. The results showed that most medical students (80.8%) had a unimodal learning style, with 48.8% being kinesthetic, and only 19.2% were multimodal. The study also found a significant association between gender and visual and auditory learning styles where female students had a visual preference and males had an auditory prevalence. Also, a significant association

was found between auditory and kinetic preferences with the university grade and attending lectures. Furthermore, all VARKs had a significant association with the developed integrated medical education program (49).

2. A study on 133 medical students aimed to understand the learning styles of pre-clinical and clinical medical students in Dubai Medical College using the VARK questionnaire. The results showed a statistically significant difference between pre-clinical and clinical students in the mean of different VARK learning styles. Pre-clinical students had a preference for multimodality more than clinical students (75% and 69%, respectively). The quadmodal learning preference (VARK) was the preferred model for 23.3% of the students, followed by the kinesthetic style. There was no statistically significant difference between the pre-clinical and clinical students in the different combinations of the bimodal preference except for the visual-reading combination (50).

14. Iraq

1. A study interviewed first-year (pre-clinical) and sixth-year medical students of the University of Babylon, College of Medicine (50 first-year pre-clinical undergraduate medical students (n=50); 50 sixth year-clinical undergraduate medical students, n=50) to investigate their learning methods and knowledge of learning styles and techniques of learning using the VARK questionnaire. The results showed that most first-year students had little knowledge of learning styles and techniques. Of final-year students, approximately 30% preferred bimodal, 20% preferred trimodal (especially female students), 10% preferred unimodal, and the remaining preferred quadmodal styles. It was concluded that understanding how to learn must be a standard part of the

curriculum in medical schools, and students must be aware of that (51).

4- DISCUSSION

This study reviewed and compared published articles on the learning styles of medical students worldwide using the VARK or Kolb's questionnaires. In the present study, various learning style preferences and the predominant learning approaches among medical students were studied. Based on Kolb's learning style questionnaire (874/6161), the majority of medical students had the accommodator (54.6%), and converger (52%) learning styles. The VARK questionnaire indicated that the preference for the multimodal learning style ranged from 13.2% (Saudi Arabia) to 87% (Iran) across worldwide studies, with 70% being kinesthetic. The results of the present study showed a statistically significant relationship between gender and educational level and the learning preferences of students. An important factor in determining the learning style of individuals is cultural and environmental influences during the formation of the dominant learning style (52).

On the other hand, previous experiences in learning and the methods used for learning are other variables that can affect the current learning style of a student. Therefore, as Dolmans et al. state, the interaction between the environment and learning styles must be considered in determining the learning style of an individual (53). In lower levels of education, university courses are more theoretical and usually do not require extensive explanation and interpretation. However, in higher levels, especially in postgraduate studies, where learning occurs in the higher stages of Bloom's theory, the student is expected to analyze and even critique the theories of others in addition to perceptually learning different theories (54). As their learning style will

also be affected, differences appear in the learning styles of students of different levels. According to studies, the learning style is affected after entering the university and at higher levels and changes along with the educational conditions of students. Also, using different senses in the learning process is essential in increasing the learning of medical students. It is because using several sensory channels in the learning process makes learning much more effective (9). The results of the present study showed that the majority of students had adaptive and convergent learning styles. Learners with the adaptive learning style (accommodators) enjoy the implementation of projects and engage with new and challenging experiences (55). They take risks and often solve problems through trial and error (56).

Learners with a convergent style are the best in applying ideas and theories in practice. They can solve problems and make decisions based on the solutions they find. They prefer to deal with professional and technical issues rather than social and interpersonal issues (55). Convergent learners are characterized by manipulating objects, logical analysis of planning ideas, and learning through thinking (57). In the convergent learning style, the abstract and experimental methods of divination are combined. Learners with this learning style are the best at putting ideas and theories into practice. They can solve problems and make decisions based on the solutions they find to problems (58, 59). The preferred teaching method for the convergent style is teacher presentation methods, diagrams, and manuscripts (60). The accommodator learning style combines the methods of objective experience and active experimentation. Accommodators enjoy drawing plans and engaging with new and challenging experiences and tend to do analytics instead of logic. Adapters are more likely to use information from people than rely on their own technical analysis to

solve problems. This learning style is more effective in active occupations, such as marketing or sales. The preferred teaching method for adapters is role-playing and computer simulation. Lack of knowledge about learning styles and their uses may result in students failing in their learning (58-61). Kaufman believes in interactive lecturing with note-taking, small group learning sessions, web-based learning programs, and studies based on inclusive direct analysis. Each of these methods motivates different learners differently to apply new learning methods in different situations (62).

5- CONCLUSION

This study showed a variation in the learning style preference among pre-clinical and clinical students. Based on Kolb's learning style inventory, the majority of students had the accommodator (54.6%), and converger (52%) learning styles. Based on the VARK inventory, the preference for the multimodal learning style (bimodal) in worldwide studies ranged from 13.2% to 87%, with 70% being kinesthetic. In addition, the results showed that factors such as gender and educational level play a significant role in determining the dimensions of learning styles. Paying attention to these factors helps in recognizing the learning styles of students more effectively. By considering them in educational planning and teaching design, educational activities can be presented in better coordination with the learners' learning styles.

6- AUTHORS' CONTRIBUTIONS

Study conception or design: FS, and SS; Data analyzing and draft manuscript preparation: MG, NM, MS, and ZR; Critical revision of the paper: MG, and SS; Supervision of the research: FS and SS; Final approval of the version to be published: FS, MG, NM, MS, ZR, and SS.

7- CONFLICT OF INTEREST: None.

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