

A Comparison of Undergraduate Prosthodontic Teaching of Removable Partial Dentures in Saudi Arabian Dental Colleges with North American and Turkish Dental Schools

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ABSTRACT

Objectives: To meet the needs of society, it is obligatory to provide standardized skill training to undergraduate students in dental colleges. Surveys related to teaching curriculum are valuable means to evaluate education across the country. The aim of this study was to find the trends in the undergraduate teaching curriculum, by determining the differences in the teaching methods and principles of fabrication of removable partial dentures in dental colleges in Saudi Arabia and to compare these with the curriculum of North American dental schools and Turkish dental schools. **Materials and Methods:** An online survey was conducted in 23 dental colleges of Saudi Arabia. Descriptive data analysis was performed to synopsise the information. **Results:** Eighteen out of 23 (78.23%) dental colleges of Saudi Arabia answered the questionnaire; 88.9% of the colleges follow the practice of using custom trays for making final impressions; and 44.4% of the colleges use only polyvinyl siloxane for making final impressions. Semiadjustable articulators were commonly used for mounting study casts (61.1%) and master casts (66.6%). An in-house production laboratory is present in 72.2% of the colleges. Cobalt–chromium alloy is used in 94.4% of the colleges for the framework. A set protocol for postinsertion adjustment visits is followed in 94.4% of the colleges. **Conclusions:** Dental colleges of Saudi Arabia have similar standards of removable partial denture education at the undergraduate level, with variations in a few aspects. Removable partial denture teaching programs of Saudi Arabian dental colleges are comparable to similar programs in dental schools of the United States and Turkey.

KEYWORDS: Curriculum studies, dental education, prosthodontics, removable partial denture, Saudi Arabia

INTRODUCTION

The advancements in the medical field have increased life expectancy over the years, which, in turn, has led to an upsurge in the need for prosthodontic treatments.^[1,2] There are various treatment options for rehabilitation of partially edentulous patients, ranging from conventional to implant retained removable and/or fixed partial dentures. Although dental implants are

currently the choice of treatment for partially edentulous patients, various limiting factors such as high cost, quality and quantity of bone, patient's medical status,

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etc. make removable partial dentures (RPDs) one of the significant treatment options for the rehabilitation of elderly patients.^[3] Affordable oral health care should be systemized to ensure adequate treatment for all the elderly patients.^[4]

The undergraduate training in dental schools is the foundation for the knowledge achieved and psychomotor skills developed by students.^[5] To meet the needs of society, it is mandatory to provide standardized skill training to undergraduate students by removable prosthodontics courses in dental colleges. This standardized training program is essential to meet the goals and objectives for the accreditation of the program itself. Surveys related to the teaching curriculum are a valuable means to evaluate removable prosthodontic education across the country. Various studies in literature analyze the undergraduate prosthodontic curriculum of RPD teaching, in various dental schools across the world.^[6-10] To the best of our knowledge, currently there are no documented studies that compare the curriculum of RPD teaching across various dental colleges in the Kingdom of Saudi Arabia (KSA).

The aims of this study were

1. To find the trends in the undergraduate teaching curriculum, by determining the differences in the teaching methods and principles of fabrication of RPD in dental colleges in Saudi Arabia.
2. To compare this RPD curriculum in dental colleges in Saudi Arabia with the curriculum of North American dental schools and Turkish dental schools.

MATERIALS AND METHODS

An online survey was conducted in the year 2019, to know the undergraduate prosthodontics clinical teaching curriculum of RPD, in 23 dental colleges of Saudi Arabia, via Google Forms (a survey administration App). The verified questionnaire used by Vicki C. Petropoulos and Behnoush Rashedi^[6] was used, with minor modifications, as our benchmark. There are 16 multiple-choice questions, and a few questions are open-ended. These allow participants to add any supplementary information. Ethical clearance from the Research board at the College of Dentistry, Jazan was obtained (No: CODJU: 1812I). To evaluate content and face validity, the questionnaire was administered to two faculty of the Department of Prosthetic Dental Sciences, who are actively involved in RPD teaching. To assess the face validity of the questionnaire, it was administered to five faculty members through interviews. All the participants found the questionnaire

to be appropriate and easy to understand. Cronbach's α value of 0.80 ($P < 0.05$) was obtained when the questionnaire was later subjected to test-retest (with a time gap of one week) reliability. An email was sent to the chairman of Prosthodontic/SDS departments of 23 dental colleges (both government and private), having complete undergraduate dental degree programs, in Saudi Arabia. A cover letter explaining the purpose of the study and link of the survey (Google forms) were sent as an email attachment. In case of no response from the department chairman, a reminder email was sent after one week, followed by an attempt to contact via telephone. After the failed response for two weeks, the survey was sent to one of the senior faculty members (either the course coordinator or one actively involved in teaching removable prosthodontics) of that college. Confidentiality of all the participants and the colleges was maintained. No benefits were promised or given to any of the participants for attending the survey. Data were collected over a period of two months. One response from each college (most recent entry) was considered for analysis purpose. As all the forms received were adequately filled, none of the questionnaires was excluded from the study.

DATA ANALYSIS/STATISTICS

Collected data were tabulated in a Microsoft Excel Spread sheet (Microsoft Inc., Redmond, WA), and statistical analysis was performed by using software SPSS 20 for Windows (SPSS Inc., Chicago, IL). Descriptive data analysis was performed to synopsise the information. A comparison was done with a similar study previously conducted in the United States^[6] and Turkey,^[9] using the chi-square test. For all the performed analyses, a $P < 0.05$ was regarded as statistically significant.

RESULTS

A response rate of 78.3% was achieved as 18 out of 23 dental colleges of Saudi Arabia answered the questionnaire. The results for question 1 (Q1) are summarized in Table 1, whereas Table 2 summarizes the answers for questions 2 to 16 (Q2-Q16) in the questionnaire and compares data with a similar study performed in the dental schools of the United States and Turkey. There were statistically significant differences between Saudi Arabian dental colleges and U.S. schools with respect to the distribution of responses for questions four to nine and eleven to thirteen ($P < 0.05$). Statistically significant differences were found between Saudi colleges and Turkish schools with respect to relief areas in custom trays (Q5) ($P = 0.034$), materials used in making the final impression (Q6) ($P = 0.007$),

type of articulator used for mounting master casts (Q8) ($P = 0.025$), flasking procedures being performed by students themselves (Q9) ($P = 0.013$), availability of own production laboratory (Q12) ($P = 0.0001$), following set protocols for recall visits (Q14) ($P = 0.0006$), and counting interim/ transitional RPD toward graduation course requisites (Q16) ($P = 0.0001$).

DISCUSSION

Before rehabilitating partially edentulous patients, it is necessary that the oral cavity should have healthy tissues. This makes RPD fabrication a unique and complex treatment modality in itself. The budding dentists should have thorough knowledge that is necessary for diagnosis and treatment planning, and fine motor skills required for performing clinical and laboratory steps for RPD fabrication. An undergraduate education program forms the foundation of knowledge and skills to tackle any clinical challenges further in life. Due to the publicity and success of dental implantology,^[2,11] undergraduate students are more fascinated with fixed prosthodontics. Despite that, the education and training standards of removable prosthodontics teaching in dental colleges should not be compromised, as a large section of the population still needs to be rehabilitated by RPD due to one or the other reasons.

The results of the current survey show that the RPD education process in dental colleges of Saudi Arabia have similarities in most aspects. Most of the colleges follow and teach their undergraduates the same basic principles and techniques of RPD fabrication. The results of this survey were compared with similar studies conducted in the United States^[6] and Turkey.^[9] As per our knowledge, the last documented data from the United States were from a study conducted in 2006.^[6] Teeth from Ivoclar Vivadent are the most commonly

used (33%) by undergraduates for RPD in different colleges of Saudi Arabia. This result was different from the results of studies by Petropoulos *et al.*^[6] and Dikbas *et al.*^[9] The ease of availability of this standardized product may be the reason for its common usage. In Saudi Arabia, none of the colleges use porcelain teeth at the undergraduate level. This may be due to some inherent drawbacks of porcelain denture teeth,^[12,13] including difficulties encountered during the process of occlusal equilibration,^[14] which may be challenging at the undergraduate level.

Most of the colleges (88.9%) in the current study follow the practice of using custom trays for making final impressions. The number of schools using custom trays is less in U.S. schools (48%),^[6] whereas all Turkish schools (100%) use custom trays.^[9] According to us, the use of custom trays should be advocated to relieve the necessary areas and to have better control of impression material, which is even more essential at the undergraduate level. In the current study, 83% of the dental colleges instruct their students to perform border molding of the custom tray in the edentulous area. Our result is in consensus with that of Petropoulos *et al.*^[6] (80%) and less than that of Dikbas *et al.* (100%).^[9] Border molding of the edentulous area is an important step for recording the depth and width of the vestibule. This procedure allows the dentist to extend the prosthesis to the greatest limits, allowing better stress distribution.^[12] Thus, it is advocated that the habit of performing border molding of edentulous areas should be well instilled in the students.

In most of the dental colleges (77.8%) of Saudi Arabia, modeling plastic is the choice of material for students to perform border molding. In comparison to the results of Dikbas *et al.* (94.1%),^[9] a less number of colleges in Saudi Arabia use modeling plastic. A statistically significant

Table 1: Responses given by Saudi Arabian dental colleges for question number 1, as compared with U.S. and Turkish dental schools

Q1. What type of artificial acrylic teeth do your students use for removable partial denture patients?	Saudi Arabia Dental Colleges		U.S. Dental Schools		Turkish Dental Schools	
	n	(%)	n	(%)	n	(%)
Pala premium (Kulzer) only	1	5.6	NA	–	NA	–
Bioblend only	0	0	3	7	NA	–
Ivoclar Vivadent only	6	33.3	0	0	NA	–
Bioform only	4	22.2	0	0	NA	–
Myerson only	0	0	1	2	NA	–
Optodent only	NA	–	NA	–	4	23
Vita only	NA	–	NA	–	1	5.9
Others (Welbite, Mondial, NT Unay, portrait, Ivoclar porcelain, Majordent, Yamachi, Megaplus, Eray, NT Optima, or a combination of any of the above mentioned teeth)	4	22	29	66	12	71.1

Table 2: Responses given by Saudi Arabian dental colleges for question numbers 2–16, as compared with U.S. and Turkish dental schools

Question	Response	Saudi Arabian Dental College (18)	U.S. Dental Schools (44)	p-value (KSA** Vs. USA)	Turkish Dental Schools (17)	p-value (KSA** Vs. Turkey)
		n (%)	n (%)		n (%)	
Q2. For making final impressions of partially edentulous patients, are you instructing your students to use a custom tray?	Yes	16 (88.9%)	21 (48%)	0.199	17 (100%)	0.156
	No	0	4 (9%)		0	
	Sometimes	2 (11.1%)	18 (41%)		0	
Q3. Before making the final impression for removable partial dentures, are students instructed to perform border molding of a custom tray in edentulous areas?	Yes	15 (83.3%)	35 (80%)	0.125	17 (100%)	0.078
	No	0	7 (16%)		0	
	Other	3 (16.7%)	2 (4%)		0	
Q4. What material (s) is/ are recommended to students for border molding of custom trays, for partial denture fabrication?	Modeling plastic impression compound	14 (77.8%)	27 (61%)	0.0001*	16 (94.1%)	0.348
	Polyvinyl siloxane	0	1 (2%)		0	
	Polyether	0			0	
	Polysulfide	0			0	
	Wax materials	1 (5.6%)			0	
	Combination of above	3 (16.6%)	10 (23%)		1 (5.9%)	
	Other	0	6 (13%)		0	
Q5. Are students taught to relieve some area(s) in custom trays for removable partial denture? Please specify.	Relief on teeth areas only	0	6 (14%)	0.0001*	4 (23.5%)	0.034*
	Relief on edentulous area only	3(16.6%)	1 (2%)		3 (17.6%)	
	Relief on teeth and edentulous areas	12 (66.6%)	29 (66%)		7 (41.2%)	
	No relief	1 (5.6%)	3 (7%)		1 (5.9%)	
	Other	1 (5.6%)	3 (7%)		2 (11.8%)	
	Relief on teeth only or both teeth and edentulous areas	1 (5.6%)	0		0	
Q6. For removable partial denture fabrication, which final impressions material(s) are being used by students?	Polysulfide rubber base	2 (11.1%)	7 (16%)	0.0001*	0	0.007*
	Polyether	1 (5.6%)	1 (2%)		0	
	Polyvinyl siloxane	8 (44.4%)	3 (7%)		5 (29.4%)	
	Irreversible hydrocolloid	2 (11.1%)	11 (25%)		12 (70.6%)	
	Polysulfide and polyvinyl siloxane	0	4 (9%)		0	
	Polysulfide and irreversible Hydrocolloid	0	6 (14%)		0	
	Polysulfide+ Polyvinyl siloxane+ Irreversible hydrocolloid	2 (11.1%)	4 (9%)		0	
	Polyvinyl siloxane+ Irreversible Hydro	3 (16.7%)	6 (14%)		0	
	Others	0	2 (4%)		0	
Q7. For mounting study casts, which category of articulators is used by students while fabricating removable partial dentures?	Simple hinge-type articulator with lateral movement capacity	4 (22.2%)	2 (5%)	0.0001*	9 (53%)	0.07
	Simple hinge-type articulator without lateral movement capacity	3 (16.7%)	0		4 (23.5%)	
	Semiadjustable articulator	11 (6.1%)	40 (90%)		4 (23.5%)	
	Other	0	0		0	

Table 2: Continued

Question	Response	Saudi Arabian Dental College (18)	U.S. Dental Schools (44)	p-value (KSA** Vs. USA)	Turkish Dental Schools (17)	p-value (KSA** Vs. Turkey)
		n (%)	n (%)		n (%)	
Q8. For mounting master casts, which category of articulators is used by students while fabricating removable partial dentures?	Simple hinge-type articulator with lateral movement capacity	2 (11.1%)	1 (2%)	0.0001*	9 (53%)	0.025*
	Simple hinge-type articulator without lateral movement capacity	2 (11.1%)	0		4 (23.5%)	
	Semiadjustable articulator	12 (66.6%)	43 (98%)		4 (23.5%)	
	Other and semiadjustable articulator	1 (5.6%)	0		0	
	Simple hinge-type articulator with lateral movement capacity and semiadjustable articulator	1 (5.6%)	0		0	
Q9. For removable partial denture cases, do the students perform flasking procedures by themselves?	Yes	1 (5.6%)	1 (2%)	0.0001*	6 (35.3%)	0.013*
	No	12 (66.7%)	41 (93%)		11 (64.7%)	
	Sometimes	5 (27.8%)	2 (5%)		0	
Q10. Which material/ alloy is used for fabricating framework for removable partial denture cases?	Chrome cobalt	17 (94.4%)	31 (70%)	0.107	17 (100%)	0.324
	Nickel-chromium	0	6 (14%)		0	
	Gold alloys	0	0		0	
	Titanium alloys	0	0		0	
	Aromatic polymers	0	0		0	
	Others	1# (5.6%)	7 (15.9%)		0	
Q11. Are undergraduate students using removable partial dentures with attachments, for their patients?	Yes	3 (16.7%)	27 (61%)	0.001*	4 (23.5%)	0.611
	No	15 (83.3%)	17 (39%)		13 (76.5%)	
Q12. (a) Does the dental college have its own production laboratory for fabrication of removable partial denture frameworks?	Yes	13 (72.2%)	15 (34%)	0.001*	0	0.0001*
	No	5 (27.8%)	29 (66%)		17 (100%)	
(b) If yes, are students allowed to cast a removable partial denture framework?	Yes	0	3 (20%)	0.087	–	–
	No	13 (100%)	12 (80%)		–	
Q13. Is it mandatory for students to use the altered cast technique, in distal extension removable partial denture situations?	Yes	6 (33.3%)	26 (59%)	0.001*	2 (11.8%)	0.306
	No	10 (55.6%)	8 (18%)		13 (76.5%)	
	Other	2 (11.1%)	10 (23%)		2 (11.8%)	
Q14. Do students follow a set protocol (if any), for postinsertion adjustment visits of their removable partial denture cases?	Yes	17 (94.4%)	41 (93%)	0.50	7 (41.2%)	0.0006*
	No	1 (5.6%)	2 (5%)		10 (58.8%)	
Q15. Does the graduate program require completion of a minimum number of removable partial denture arches (1 unit = 1 arch)?	Yes	18 (100%)	34 (82%)	0.157	16 (94.1%)	0.296
	No	0	10 (18%)		1 (5.9%)	
If yes, what is the number (mean value)?		3	3	–	8	–

Table 2: Continued

Question	Response	Saudi Arabian Dental College (18)	U.S. Dental Schools (44)	p-value (KSA** Vs. USA)	Turkish Dental Schools (17)	p-value (KSA** Vs. Turkey)
		n (%)	n (%)		n (%)	
Q16. Do transitional/interim removable partial dentures count as arches or partial arches toward graduate course requisites?	Yes	15 (83.3%)	20 (45%)	0.115	1 (5.9%)	0.0001*
	No	3 (16.7%)	23 (52%)		16 (94.1%)	

*Chi-square test applied, *P*-value significant at $P < 0.05$

#No cast dentures are being made

**KSA: Kingdom of Saudi Arabia

difference is noted between our results and the results of the study by Petropoulos *et al.* (61%).^[6] Each technique of border molding (single step and incremental) has its own advantages and disadvantages.^[12,15,16] At the undergraduate level, students are in the learning phase and it is convenient for them to follow the incremental technique (using modeling plastic) as compared with the single-step technique (using polyvinyl siloxane) of border molding. Apart from this, cheaper cost can also be a reason for its popularity. Our finding, where 66.6% colleges teach their students to provide relief on both teeth and edentulous areas in custom trays, completely coincides with that of Petropoulos *et al.* (66.6%).^[6] There was a statistically significant difference between our results and those of Dikbas *et al.*,^[9] where relief was provided on both teeth and edentulous areas in 41.2% of schools and 23.5% of schools recommended relief only for teeth.

In the current study, polyvinyl siloxane (44.4%) was the most commonly used material for making the final impression, followed by polysulfide (11.1%) and irreversible hydrocolloid (11.1%). There was a statistically significant difference between the results of our study, and the results of both Petropoulos *et al.*^[6] and Dikbas *et al.*^[9] in this aspect. Irreversible hydrocolloid was the most commonly used material in U.S. schools (25%) and Turkish schools (70.6%). Polyvinyl siloxane records rest seat area more accurately and have better dimensional stability (in case of delay in pouring the cast), as compared to irreversible hydrocolloids.^[17] Semiadjustable articulators were the choice of articulator for mounting study casts (61.1%) and master casts (66.6%) in the current study. Petropoulos *et al.* reported a significantly higher percentage of the use of semiadjustable articulators (90% and 98%, respectively).^[6] On the contrary, Dikbas *et al.*^[9] showed that most of their schools use a simple hinge-type articulator with lateral movement capacity

(53% and 53%, respectively). It is highly recommended to all dental colleges to use semiadjustable articulators for fabrication of RPD, as this will decrease the occlusal errors.

An in-house production laboratory is present in 72.2% of the dental colleges in the current study. In 66.7% of the colleges, students do not perform flasking procedures themselves and none of the colleges allow students to cast an RPD framework by themselves. There is significant difference between the current study and the study by Petropoulos *et al.*,^[6] where 61% of the schools have an in-house lab; out of that, 20% allow students to cast an RPD framework, and 93% do not perform a flasking procedure. On the contrary, in the study by Dikbas *et al.*,^[9] none of the dental schools (0%) have an in-house production lab and a significantly higher number of school students perform the flasking procedure by themselves (35.3%). An in-house production lab should be present, and students must be trained to perform all laboratory steps by themselves. In prosthodontics, clinical and lab steps are linked, and they are dependent on each other. Practical knowledge of laboratory steps helps dentists in guiding professional labs. Almost all the colleges (94.4%), except one college where CRPDs are not fabricated, use the Co–Cr alloy for fabricating the RPD framework. This is similar to the results of the study by Dikbas *et al.* (100%),^[9] whereas the study by Petropoulos *et al.*^[6] showed that only 70.45% schools use only Co–Cr alloys. Though the Co–Cr alloy is the choice of material for RPD fabrication, advanced materials such as thermoplastic nylons and newer polycyclic aromatic thermoplastic polymers are now a part of clinical practice.^[18] Undergraduate students should be exposed to these newer materials, so that they know all the available treatment options when they set up their practice.

In the current study, 16.7% of dental colleges allow students to use RPD with attachments for their

patients. Both Petropoulos *et al.*^[6] and Dikbas *et al.*^[9] reported higher numbers (39%, statistically significant and 23.5%, respectively). The use of attachments is a complex procedure and we feel that their use should be limited to postgraduate courses. The use of the altered cast technique for all distal extension cases is mandatory in only 33% of dental colleges of Saudi Arabia. This is significantly less as compared with the results of the study by Petropoulos *et al.* (59%).^[6] However, in a study by Dikbas *et al.*,^[9] this procedure is mandatory in only 11.8% of the schools. The altered cast technique is generally considered as a gold standard for making impressions for distal extension cases in most of the countries, but the clinical significance of this procedure is still debatable.^[19,20]

The students of almost all the colleges in the current study (94.4%) and in those of the study by Petropoulos *et al.* (93%)^[6] follow a set protocol for postinsertion adjustment visits of their RPD cases. However, this practice is less commonly seen in the study by Dikbas *et al.* (41.2%).^[9] The postinsertion phase is very critical for patient counseling and training to achieve successful treatment outcomes of RPD cases. The importance of the postinsertion phase should be instilled in students by following a set protocol every time. In all participating dental colleges (100%) of the current study, a graduate program requires completion of a minimum number of units of RPD arches. This number varied from 1 to 5, with a mean number of 3 units as the minimum requirement. The study by Petropoulos *et al.*^[6] showed that 82% schools have a mean 3 units as the minimum requirement, whereas 94.1% schools have 8 units as the minimum requirement as reported by Dikbas *et al.*^[9] Students should be exposed to the maximum number of quality clinical cases, based on the credit hours allocated for the course. Most of the colleges (83.3%) in the current study count transitional/ interim RPDs as arches toward graduate course requisites. Results vary from those in the study by Petropoulos *et al.*,^[6] where only 45% colleges agree to this. On the contrary, only 5.9% of schools in the study by Dikbas *et al.*^[9] agreed to this number.

LIMITATIONS OF THE STUDY

The current study employed a cross-sectional survey involving all dental colleges of Saudi Arabia.

There are multiple variables (Resource Materials, Physical Facilities, Culture and Ideology, Instructional Supervision, Accreditation or registration requirements, existing centralized education system, etc.)^[21,22] that affect the curriculum at the undergraduate level. Further studies are required to compare the effect of these variables.

CONCLUSION

Within the limitations of this study, it can be concluded that most of the dental colleges of Saudi Arabia have similar standards of RPD education at the undergraduate level, with variations in a few aspects. The RPD teaching programs of Saudi Arabian dental colleges are comparable to similar programs in dental schools of the United States and Turkey. With the increasing number of patients in need of RPDs, the undergraduate removable prosthodontic programs need to maintain high standards. We recommend further extensive surveys comparing other aspects of RPD teaching in Saudi Arabia and worldwide. The feedback from the beneficiaries of these programs should be further used for improving and standardizing the RPD teaching curriculum.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHORS' CONTRIBUTIONS

Hafiz Adawi: Conceptualization, Methodology, Investigation, Writing - Original Draft, Writing - Review & Editing. Saurabh Jain: Conceptualization, Methodology, Investigation, Writing - Original Draft, Writing - Review & Editing, Supervision. Afnan Yahya M. Atiah: Methodology, Investigation, Resources, Writing - Review & Editing. Najwa Khaled Salwy: Methodology, Investigation, Resources, Writing - Review & Editing. Lamyaa Ali M. Khormi: Methodology, Investigation, Resources, Writing - Review & Editing. Sumayyah Ahmed Adawi: Conceptualization, Resources, Writing - Review & Editing. Aeshah Y. M. Atiah: Conceptualization, Resources, Writing - Review & Editing. Aparna Aggarwal: Conceptualization, Resources, Writing - Original Draft, Writing - Review & Editing..

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

Ethical permission was granted by Ethics and Review Committee, College of Dentistry, Jazan University. All the procedures have been performed as per the ethical guidelines laid down by the Declaration of Helsinki.

PATIENT DECLARATION OF CONSENT

Not applicable.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author on reasonable request.

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