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Socio-demographic Profile of Orthodontic Patients and Their Retrospective Reflections on Orthodontic Treatment Received during COVID-19 Pandemic from A Tertiary Care Public Dental Hospital in Sri Lanka

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ABSTRACT

Objectives: This study explored the socio-demographic profile of orthodontic patients and their retrospective reflections on orthodontic treatment services that they received during COVID-19 pandemic from a tertiary care public dental hospital in Sri Lanka. The relationships between age, gender and educational attainment of orthodontic patients and their retrospective reflections on perceived safety of receiving orthodontic treatment during COVID-19 pandemic and uncertainty in obtaining expected orthodontic treatment outcomes due to postponement of appointments were also assessed.

Materials and Methods: Patients who were aged 18-44-years and attended orthodontic treatment during the pandemic with ongoing treatment at the time of data collection participated in this study. The sample comprised 400 orthodontic patients and data was collected using a pre-tested, self-administered questionnaire complimented by clinical records and patients' registers.

Results: Females (70.3%) and young adults (78.2%) dominated the sample and 51.7% accessed orthodontic treatment during the COVID-19 pandemic. Patients reflected their agreement with infection control protocols implemented, such as pre-screening (78.3%) and restricted treatment provision (75.6%). Moreover, patients echoed perceived safety in receiving routine orthodontic treatment during the pandemic with the mean score (95% CI) of 59.68 (56.67-62.68) which was significantly associated with their educational attainment. More educated patients perceived safety better than their less educated counterpart ($p=0.0001$). However, such associations were not evident pertaining to perceived uncertainties in accomplishing orthodontic treatment outcomes due to postponement of routine orthodontic treatment as experienced by 70.8% of respondents. Making arrangements for online appointments was suggested by orthodontic patients to improve services during pandemics.

Conclusion: Orthodontic patients reflected their agreement with infection control protocols that were implemented during the pandemic, but articulated uncertainties in achieving expected treatment outcomes due to postponement of appointments. Regardless of the limitations, the findings of this study could help in streamlining publicly funded orthodontic treatment services amidst resource constraints, during and after future pandemics.

Keywords: Reflections, Perceptions, Orthodontic patients, COVID-19 pandemic, Restricted treatment, Infection control protocols, Uncertainties.

1. Introduction

The COVID-19 global pandemic made an indelible impact on the health and social life of people, health systems, and economic structures of countries across the globe (1,2). Stringently imposed lockdown scenarios, physical and social distancing, extensive cross-infection control measures resulted in inevitable impairments to dental treatment services including orthodontic treatment services in almost all countries (2-5). It is also known that despite widespread vaccination, COVID-19 has not been eradicated or eliminated from the world (6) and as at present Asia is witnessing a new wave driven by highly transmissible JN.1 subtype with rapidly rising caseloads in Singapore, Hong Kong and Thailand. The World Health Organization recently declared M-pox to be a global health threat for the second time in three years, thus raising fears of another impending global pandemic (7). Therefore, it is reasonable to argue that preparedness for present and future global pandemics of public health importance becomes imperative for all health care providers.

The Occupational Safety and Health Administration (OSHA) classified dentistry as a “very high risk” profession attributed to transmission of the SARS-CoV2 virus via aerosol generation procedures (8). Therefore, explicit standard guidelines and safety protocols for dental practices in COVID-19 era were established (9). Many countries provided only emergency dental treatment and even after passing the COVID-19 era appointments were restricted and the volume of patient care services has not yet reached completely the pre-COVID-19 era (10-12).

Orthodontic treatment continues for a long period and relies on patient compliance and consistent evaluation and adjustment of active appliances whilst addressing emergencies that might occur (12). Therefore, pandemics and consequent breakdown of orthodontic treatment services could pose layers of uncertainty and worries to patients (13-15) whilst imposing many challenges to clinicians (16-17). An in-depth exploration on aspects of perceived uncertainty and related factors of orthodontic treatment, such as receiving services in orthodontic emergencies, perceptions on progress and future of orthodontic treatment, clinic setting, clinic safety, adequacy of personal protective equipment protocols and their pretesting, use of teleorthodontics during the pandemic could provide invaluable information (18-23). This

becomes crucial, not only in planning patient-centered, safe and effective orthodontic treatment services in future pandemics, especially in countries facing economic crises as well as assessment of the quality, safety and satisfaction for patient care provided during the pandemic. Such information is particularly useful for a country with many economic constraints and challenges in investing in costly orthodontic treatment services as public treatment services.

Sri Lanka is a lower-middle-income country (LMIC) striking through a major economic crisis (24). Therefore, providing orthodontic treatment from public sector orthodontic clinics amidst many resource constraints is challenging. Sri Lanka possesses a unique public healthcare delivery model which includes general and specialized oral health care services. Accordingly, orthodontic treatment services are provided through a nationwide network of public hospital-based clinics. The demand for public sector orthodontic treatment services is on the rise as the services are provided without direct user fees. Each public orthodontic clinic is attended by approximately 75-100 patients per day, however, numbers become double for orthodontic units in tertiary care hospitals (25,26). On average 300-400 new patients are being registered per month and placed on a waiting list, thus demonstrating the escalating demand for orthodontic treatment from public sector orthodontic clinics (25,26). The years 2020 and 2021 marked the era of COVID-19 pandemic with active waves of infection transmission in Sri Lanka with stringently imposed lock down scenarios (27), however, followed by periods of remissions and resumption of oral health care services (28). Despite restricted patient care services, routine orthodontic treatment services were provided during the COVID-19 pandemic (24) at the times remissions adhering to stringent infection control protocols that included prescreening and triaging of patients and provision of Polymerase Chain Reaction (PCR) or Rapid Antigen Testing (RAT) reports prior to providing aerosol generating orthodontic treatment procedures. As revealed by performance statistics in the year 2020, a total of 184958 orthodontic patients accessed public sector orthodontic treatment services providing all types of appliances (26). The total number of patients who received orthodontic treatment from public hospitals rose even further 2021 and 2022 (25) as the COVID-pandemic was brought to a greater control in Sri Lanka.

However, there is a gap in the understanding of how orthodontic patients perceived the orthodontic treatment services that they received during the pandemic from orthodontic clinics of public hospitals in Sri Lankan context with regard to infection control protocols, possible risk of infection transmission while receiving orthodontic treatment, perceived safety in receiving routine orthodontic treatment as well as postponement of orthodontic treatment during the pandemic. Moreover, it is unclear how the socio-demographic landscape of orthodontic patients influenced their perceptions on orthodontic treatment that they received during COVID-19 pandemic. Those findings will be useful in navigating and streamlining orthodontic treatment services gripped by high demand and resource constraints for future pandemics. Against this backdrop, this study was undertaken to address research questions of ‘What are the retrospective reflections of orthodontic patients on orthodontic treatment that they received during COVID-19 pandemic from a publicly funded orthodontic clinic of a LMIC gripped by an economic crisis with many resource constraints? ‘as well as ‘Whether there is an association between the retrospective reflections of orthodontic treatment that they received during COVID-19 pandemic and socio-demographic profile of orthodontic patients?’. Therefore, this study aimed to explore socio-demographic profile of orthodontic patients, their retrospective reflections on orthodontic treatment services they received during the COVID-19 pandemic from a premier, multispecialty tertiary care public dental hospital in Sri Lanka. This study also attempted to assess relationships between age, gender and educational attainment of orthodontic patients and their retrospective reflections on perceived safety of receiving orthodontic treatment during COVID-19 pandemic and uncertainty in obtaining expected orthodontic treatment outcomes due to postponement of appointments.

2. Materials and Methods

A retrospective cross-sectional study was conducted among orthodontic patients on ongoing orthodontic treatment who also accessed orthodontic treatment during COVID-19 pandemic. Therefore, the data-collection period was from 10th March 2024 to 10th July 2024 to explore their retrospective reflections on the orthodontic treatment that they received during the

COVID-19 pandemic. The study setting was the orthodontic unit, National Dental Hospital (Teaching) Sri Lanka. The inclusion criteria comprised orthodontic patients who are citizens of Sri Lanka above 18-years but less than 45- years from any province of the country, registered for orthodontic treatment at the Orthodontic Unit, National Dental Hospital, Colombo and attending the orthodontic treatments during the pandemic from March 2020 to March 2023, that included all the waves of infection transmission as well as reporting of sporadic cases. The exclusion criteria were orthodontic patients with special health care needs that included psychological disorders and patients with craniofacial syndromes. Clinical records of patients and patients’ registers were traced back to 2020-2023 to select eligible patients for the study.

Ethical approval for the study was obtained from the Ethics Review Committee of the Post Graduate Institute of Medicine, University of Colombo. Written informed consent was obtained from the patients using information sheets and consent forms. Patients were informed that they have the right to withdraw from the study at any stage. Administrative permission was obtained from the Consultant Orthodontists and Director, National Dental Hospital (Teaching) Sri Lanka.

The sample-size calculation was performed with Lwanga and Lemeshow formula (29), with 95% confidence interval as 1.96, expected proportion as 50% and absolute precision as 0.05. In the absence of published studies that assessed perceptions of orthodontic patients on the orthodontic treatment that they received during the COVID-19 pandemic in Sri Lankan context, the expected proportions of favorable and unfavorable perceptions were assumed to be 50%. Hence, the minimum sample size deemed 384 which was increased by 5% non-response rate. Therefore, the sample size was 403. However, as 3 patients had incomplete clinical records with regard to orthodontic treatment that they received during COVID-19 pandemic, they were excluded. Therefore, the sample size for the study was 400. Ideally a random sample should have been drawn from the study population. However, considering low turnover rates during the pandemic, all who fulfilled the inclusion criteria were selected for the study. Sampling units were recruited until the required sample size was obtained.

The data-collection instruments comprised a

structured, self-administered, pre-tested questionnaire made in Sinhala, Tamil and English languages and a clinical data recording form. The former consisted of the following sections: 1) Socio-demographic information: age, gender, residential district, educational attainment and employment status, 2) Reflections on infection control and other restrictive patient care protocols implemented in COVID-19 pandemic: preference personal protective equipment (PPE) of the orthodontic treatment provider, agreement with restricted treatment services during the pandemic, agreement with adequacy of pre-screening and triaging, getting PCR/RAT done prior to receiving orthodontic treatment, 3) Reflections on accessing orthodontic treatment during the pandemic: accessing orthodontic treatment during the pandemic, postponement of appointments and the reasons, perceived safety in receiving routine orthodontic treatment during the pandemic and perceived uncertainty in achieving expected treatment success attributed COVID-19 induced treatment delays, 4) and suggestions for new strategies to improve quality of orthodontic care during the pandemic.

The clinical data-recording form was filled in by the principal investigator to complement patient reports. Pre-testing of the questionnaire was carried out among 25 patients attending the orthodontic unit, Teaching Hospital Karapitiya. Necessary modifications were made to the questionnaire after pre-testing to improve clarity and understandability.

Patients who met the inclusion criteria were identified and were invited to participate in the study. Informed consent was obtained using consent forms and information sheets. Participants were provided with necessary instructions to complete the questionnaire and clarify their doubts. Completed questionnaire forms were collected by the principal investigator. The data entry and analysis were carried out using SPSS-26 Statistical Software Package. Frequency distributions and descriptive statistics are presented. Perceptions of orthodontic patients on aspects of adequacy of infection-control measures, such as triaging, pre-screening, performing PCR and RAT prior to providing orthodontic treatment, were assessed on a 5-point Likert scale as Fully disagree, Disagree, Neutral, Agree and Fully Agree. Perceived safety of receiving routine orthodontic treatment and follow up of care during Covid-19 pandemic by orthodontic patients and their perceived uncertainties in accomplishing expected

orthodontic treatment amidst obstacles posed by Covid-19 pandemic were assessed on a rating scale from 0 to 100. The latter two variables were assessed for distribution using Kolmogorov-Smirnov and Shapiro-Wilk tests of normality. As both tests deemed statistically significant ($p=0.0001$), their distributions were skewed and median score was used to dichotomize the two variables as \leq median and $>$ median score, for bi-variate comparisons using chi-square test of statistical significance. Of socio-demographic variables, age groups, gender and educational attainment were selected for bi-variate analyses.

3. Results

Table 1 illustrates the socio-demographic profile of orthodontic patients who received orthodontic care during COVID-19 pandemic from National Dental Hospital (Teaching) Sri Lanka. Orthodontic patients were dominated by young attendees aged 18-25 years and females. However, there were older patients as well. The majority of orthodontic patients accomplished General Certificate of Education-Advanced Level (G.C.E. A/L) which is equivalent to completed high school education. As evident from the findings, patients resided in districts other than Colombo and over a half were employed in private and public sectors. As per monthly household income, they mostly represented low and lower-middle- socio-economic groups.

Figure 1 depicts perceptions of orthodontic patients on aspects personal protective equipment of health care professionals during COVID-19 pandemic. Accordingly, 60.2% of patients perceived that their health care professional should wear full personal protective equipment including N-95 masks and eye shields. However, 20.6% were not concerned about the personal protective equipment used by the health care professional which must include an N-95 mask.

Table 2 shows the perceptions of orthodontic patients on infection control measures practiced during COVID-19 pandemic with regard to orthodontic treatment provision. Accordingly, the majority of patients agreed or strongly agreed with restricted treatment services. Similar agreement was evident for importance of pre-screening prior to providing orthodontic treatment. Further, a majority of patients disagreed or kept neutral on inadequacy of time taken for triaging and pre-screening. Similar pattern was evident for perceptions of orthodontic patients

undergoing PCR or RAT prior to receiving orthodontic treatment. However, as emerged from the findings, orthodontic patients demonstrated mixed perceptions on measuring body temperature as a reliable method of

detecting a COVID-19 infected person. The majority (71.9%) of orthodontic patients were aware of possibility of COVID-19 infection transmission by orthodontic treatment procedures.

Table 1: Socio-demographic profile of orthodontic patients who received orthodontic treatment during Covid-19 pandemic

Socio-demographic Profile	Number	%
Age distribution		
18-25-years	312	78.2
26-35-years	72	18.0
36-44-years	15	3.8
Gender		
Male	181	29.7
Female	219	70.3
Residential district		
Colombo	182	45.8
Gampaha	173	43.6
Kalutara	26	6.5
Other	16	4.0
Educational attainment		
Completed primary education	10	2.6
Completed secondary education	67	17.1
G.C.E. (A/L)	230	58.7
Degree	81	20.7
Other	4	1.0
Employment status		
Public sector employment	37	9.5
Private sector employment	135	34.7
Self-employed	37	9.5
Unemployed/studying	98	25.2
Not responded	82	21.1
Monthly household income		
Less than Rs.10000.00	12	3.3
Rs.10,001-30000.00	78	21.3
Rs.30,001- 50000.00	111	30.3
Rs.50,001-100,000.00	124	33.9
Above Rs.100,000.00	41	11.2

The overwhelming majority of orthodontic patients (70.8%) had experienced postponement of their routine orthodontic treatment due to COVID-19 pandemic. As depicted by Figure 2, the common reasons for such postponement were COVID-19 induced lockdown and travel restrictions. However, a little over a half of orthodontic patients (51.7%) who participated in this study have received routine orthodontic treatment services during COVID-19 pandemic.

As shown in Table 3, the mean score of 59.9 of perceptions of orthodontic patients on perceived safety of receiving orthodontic treatment revealed a favorable perception towards orthodontic treatment services that were provided. However, the mean score of 74.4 on extended time in achieving final orthodontic treatment outcomes due to missed regular appointments in Covid-19, demonstrated an uncertainty that the patients undergo.

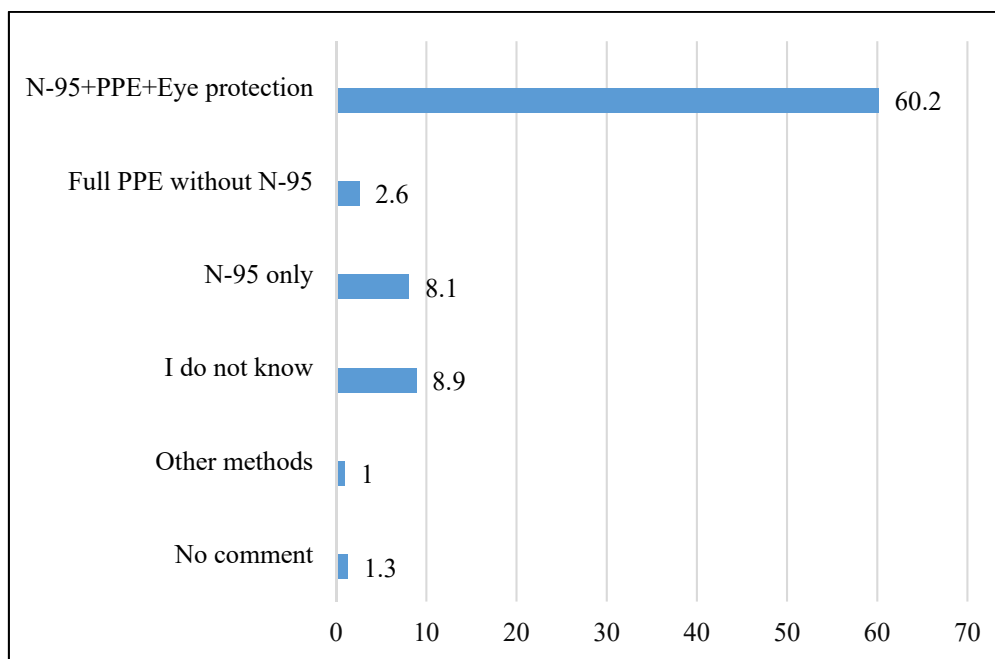


Figure 1: Perceptions of orthodontic patients on personal protective equipment of health care professionals during COVID-19 pandemic

Table 2: Percentage agreement of orthodontic patients on infection control measures practiced in providing orthodontic treatment during Covid-19 pandemic

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
'I am extremely pleased with restricted treatment services during the Covid-19 pandemic'.	2.9	3.2	18.2	44.2	31.4
'I do believe that pre-screening is important prior to providing orthodontic treatment during the Covid-19 pandemic'.	2.9	2.9	15.1	41.5	37.3
'I do feel that the time taken for triage and pre-screening was inadequate'.	9.0	34.2	38.8	14.2	3.8
'I felt scared to get done PCR/RAT prior to orthodontic treatment'.	17.3	29.4	32.3	16.2	4.9
'I do feel that measuring body temperature was a reliable method of detecting a Covid-19 infected person'.	14.9	21.3	31.3	23.3	9.3

Table 3: Descriptive statistics of perceptions of orthodontic patients on safety of receiving routine orthodontic treatment during COVID-19 pandemic and uncertainties in accomplishing expected orthodontic treatment outcomes

Statement	Mean (95% CI)	Median	Skewness	Standard Deviation
I did feel safe to attend to the orthodontic clinic during COVID 19 pandemic.	59.7 (56.7-62.7)	60.0	-.3	28.8
I do feel that time taken for achieving my final orthodontic results would be extended due to missing regular visits during the COVID 19 pandemic.	74.4 (71.7-77.2)	80.0	-1.0	26.7

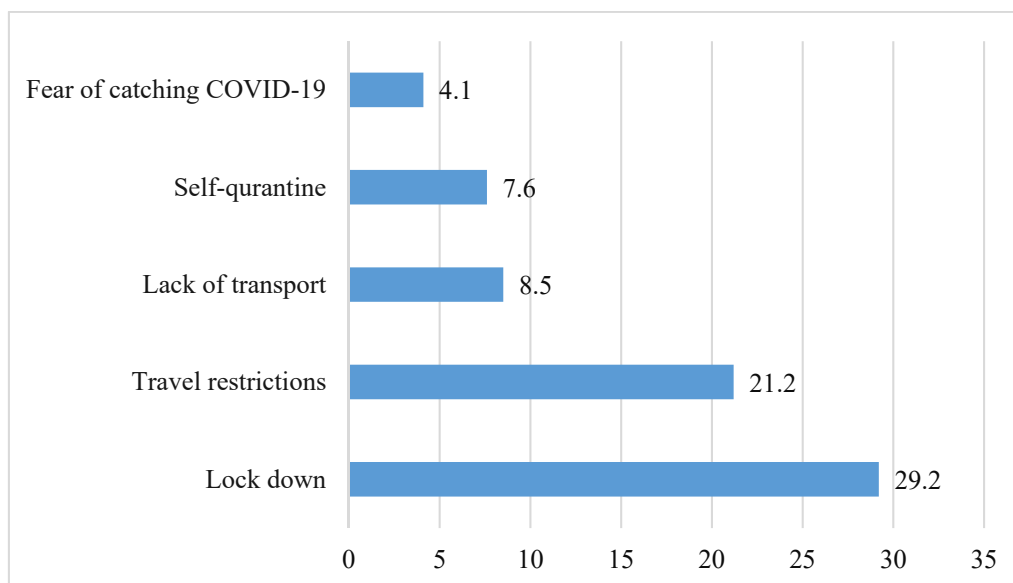


Figure 2: Patient reported reasons for postponement of orthodontic treatment during COVID-19 pandemic reported by orthodontic patients

Table 4. Comparison of perceptions of orthodontic patients on safety of receiving routine orthodontic treatment during Covid-19 pandemic by socio-demographic attributes

Perceived safety in receiving routine orthodontic treatment during Covid-19 pandemic	Socio-demographic attribute			Chi-square statistic	p-value
	Age Group				
	18-25-years	26-35-years	35-44-years	4.2	0.1
	N (%)	N (%)	N (%)		
≤median score*	162 (57.0)	28 (43.1)	8 (53.3)		
>median score	122 (43.0)	37 (57.9)	7 (46.7)		
Total	184 (100.0)	65 (100.0)	15 (100.0)		
	Gender				
	Male		Female		
	N (%)	N (%)	N (%)	3.7	0.05
≤median score	53 (46.9)	145 (57.8)			
>median score	60 (53.1)	106 (42.2)			
Total	113 (100.0)	251 (100.0)			
	Educational Attainment				
	G.C.E.O/L Completed	G.C.E. A/L and above		13.6	0.0001
	N (%)	N (%)			
≤median score	24 (65.7)	171 (58.8)			
>median score	46 (34.3)	120 (41.2)			
Total	70 (100.0)	291 (100.0)			

*median score=60.

Table 4 compares perceptions of orthodontic patients on safety in receiving routine orthodontic treatment during COVID-19 pandemic. Accordingly, a higher

proportion of 26-35-year-olds and males scored higher in their perception on safety of receiving orthodontic treatment during COVID-19 pandemic than younger

and older age groups and females. However, those differences were not statistically significant. A higher proportion of patients who attained a higher level of education scored higher than their less educated counterpart and this difference was statistically highly significant ($p=0.0001$).

As demonstrated in Table 5, there were no significant differences in the perceived uncertainty in accomplishing orthodontic outcomes attributed to postponement of routine appointments due to the pandemic.

Table 5: Comparison of perceptions of orthodontic patients on uncertainties in achieving orthodontic treatment outcomes due to postponement of appointment during Covid-19 pandemic

Perceived uncertainties in achieving orthodontic treatment outcomes due to postponement of routine appointments	Socio-demographic attribute			Chi-square statistic	<i>p-value</i>
	Age Group				
	18-25-years N (%)	26-35-years N (%)	35-44-years N (%)	1.3	0.3
≤median score*	160 (57.8)	31 (46.3)	8 (53.3)		
>median score	117 (42.2)	36 (53.7)	7 (46.7)		
Total	277 (100.0)	67 (100.0)	15 (100.0)		
	Gender				
	Male N (%)		Female N (%)	2.9	0.2
≤median score	56 (50.9)		143 (57.4)		
>median score	54 (49.1)		106 (42.6)		
Total	110 (100.0)		249 (100.0)		
	Educational Attainment				
	G.C.E.O/L Completed	G.C.E. A/L and above		1.1	0.3
	N (%)	N (%)			
≤median score	42 (60.9)	155 (54.0)			
>median score	27 (39.1)	132 (46.0)			
Total	69 (100.0)	287 (100.0)			

*median score=80.

4. Discussion

Orthodontic treatment, which is an ongoing process, relies mainly on consistent evaluation and adjustment of appliances throughout the treatment process (30). Many patients were undergoing active treatment when their care was suddenly suspended due to the pandemic (31). The British Orthodontic Society (BOS) has introduced a protocol for management of orthodontic patients during the COVID-19 pandemic (32). Furthermore, the Ministry of Health of Sri Lanka as well introduced a set of guidelines for clinical management of dental patients during COVID-19 pandemic based on internationally acclaimed guidelines.

There is voluminous research on the impact of

COVID-19 pandemic on orthodontic treatment services perceived by orthodontic patients around the world (14-23,30-39,42-47). Findings of all those studies, supported by a systematic review, demonstrated significant impacts on almost all spheres of lives of orthodontic patients who were undergoing orthodontic treatment (30-39,42-48). Many studies reported a notable negative impact on psychosocial well-being of orthodontic patients (34,35) to the extent of psychological distress and moderate levels of COVID-19 related anxiety (37,38). Supported by such evidences, it is logical to argue that the findings of those studies conducted during active phases of COVID-19 pandemic could have been confounded by factors other than perceptions of

orthodontic patients on negative impact on their ongoing orthodontic treatment compounded by lock downs, physical and social distancing, restricted travelling, fear of catching the infection and devastation caused by the pandemic. Therefore, this study explored perceptions of orthodontic patients in this regard as retrospective reflections well after curtailing the pandemic.

Given that COVID-19 now a historical event that posed a public health catastrophe and imposed a huge negative impact on orthodontic treatment services in countries around the world, the findings of this study may not arouse interest at the first glance. However, prior preparation for future pandemics becomes important to face challenges in providing orthodontic treatment. Countries that have invested on costly orthodontic treatment services as public investments whilst grappling with economic crises, resource constrains and escalating demand for services, as in the case of Sri Lanka, continuing orthodontic treatment services during pandemics become extremely challenging. Against this backdrop, the findings of the present study that explored retrospective reflections of orthodontic patients, provide novel insights into navigation and streamlining of public sector orthodontic treatment services for future pandemics embracing socio-demographic landscape of orthodontic patients.

As revealed by the findings, the majority of the patients who attended orthodontic treatments during the pandemic were young adults (78.2%) and females (70.3%). Those findings were in agreement with previous local studies (40,41) and studies conducted in other countries (31,35,42). Orthodontic patients of our study demonstrated educational attainment equal to or higher than the final examination of school after 13 years of education. They were occupied in private sector companies, public sector, self-employed or engaging in higher studies. The self-reported monthly household income of the patients was in the low and lower-middle-income category. These findings demonstrated that the young adult patients who attended a premier, public sector orthodontic clinic in Sri Lanka during the pandemic possessed a satisfactory educational background, but belonged to lower-middle class socio-economic status, not being able to afford private sector orthodontic treatments due to the cost factor.

Further, as emerged from the findings of this study, retrospective reflections of the majority of orthodontic patients favored infection control procedures

implemented during the COVID-19 pandemic. During active waves of COVID -19 pandemic with rapid community spread of the infection, routine orthodontic treatments were not carried out as per British Orthodontic Society guidelines (32). Orthodontic treatment services were confined only for emergency treatments. Most patients agreed with limited treatment provided during the phase of rapid spread of infection. This explains that the orthodontic patients were aware of the nature of spread of infection and they identified the importance of self-protection against a deadly virus. In addition, pre-screening with body temperature checks and triage of patients prior to scheduling appointments, meticulous adherence to cross-infection control, service providers attired in (PPE), infection prevention and control during and between orthodontic treatment procedures were in place which were practiced by other countries as well (22,43-45). Therefore, all orthodontic patients who needed aerosol generating treatment procedures, such as deboning, underwent PCR testing and produced a negative report. Further, RAT was performed at the dental hospital and treatment was provided only for RAT negative patients.

Routine orthodontic treatment services were provided by adhering to stringent infection control protocols, during periods of flattening of epidemic curve and control of community spread. Given the fact that a little over a half of the responding patients receiving routine orthodontic treatment during the pandemic, it is logical to argue that those favorable perceptions extended to another level as the orthodontic patients felt that it was safe to receive orthodontic treatment during the pandemic. Those findings were in line with other similar studies, as the National Dental Hospital (Teaching) Sri Lanka provided not only emergency treatment services, but also additional supportive care (27) and preventive oral health care services to special target groups, such as high caries risk toddlers and pregnant women (28). A Brazilian study reported that 19% of orthodontists provided routine orthodontic care during the COVID-19 pandemic (46). Other studies that explored perceptions of orthodontic patients on orthodontic treatment experience during the pandemic revealed that the majority of respondents were much pleased with restrictive protocols demonstrating higher levels of confidence in resuming treatment (31). Therefore, our findings as well were in agreement with studies that explored perceptions of orthodontic patients

on orthodontic treatment experience during the COVID-19 pandemic despite our study was related to retrospective reflections.

Not surprisingly, the majority (71.9%) of orthodontic patients were knowledgeable on the possibility of COVID-19 transmission by aerosol generating orthodontic treatment procedures. As the data was collected as retrospective reflections, it is reasonable to argue that patients had time to enhance their understanding in this regard. Supporting the same notion among orthodontic patients, the higher the level of education the better was the perceived safety in receiving routine orthodontic treatment during the pandemic. However, an Indian study reported that 22.3% of orthodontic patients were unaware of rapid spread of COVID-19 virus in the dental setup, yet supporting our findings, the same study reported that the majority of patients were definitely willing for their status disclosure and to undergo pretreatment screening (47). Nevertheless, Jordanian orthodontic patients disagreed with closure of orthodontic clinics during COVID-19 pandemic due to prolongation in obtaining another appointment (15). Hence, it could be reasonable to speculate that there are geographic, socio-cultural and health system based variations in perceptions of orthodontic patients on orthodontic care that they received during the pandemic.

As restricted treatment protocol was in place in active phases of COVID-19, the majority of responding orthodontic patients (70.8%) did not attend to regular follow-up appointments. The reasons for missing regular follow-up appointments, as mentioned by patients, were island-wide lockdown, travel restrictions, fear of catching COVID 19 infection, self-quarantine measures and lack of public transport facilities. Those findings were in agreement with the findings of other studies conducted among orthodontic patients in other countries during the pandemic (15-20, 30-38,). However, the missed follow-up appointments of orthodontic patients posed many challenges and uncertainties in accomplishing expected treatment outcomes. Therefore, our findings demonstrated the perceived uncertainties of orthodontic patients in accomplishing expected treatment outcomes due to COVID-19 induced postponement of routine appointments. This finding was supported by an array of similar studies conducted in other countries (15-20, 30-39). In general, the duration interval between follow-up

visits ranged from 2 weeks to one month based on severity of malocclusion and stage of the treatment. Nevertheless, this study did not explore the duration interval between follow-up visits and number of follow-up visits missed, which could have generated more conclusive evidence.

The present study was conducted in a publicly funded orthodontic clinic in a tertiary care dental hospital of an LMIC gripped by an economic crisis and resource constraints. Therefore, a separate section of the questionnaire was allocated for exploring perceptions of orthodontic patients of new strategies to improve quality of orthodontic care during pandemics. Although the number of patients who responded to this section was not significant, the responses provided were valuable. The web-based appointment was preferred over the telephone conversation to make appointments and arrange appointments in person. It is noteworthy that web-based appointments were not possible with this institution despite being a premier tertiary care public dental hospital and orthodontic appointments were fixed over the phone during the pandemic. As an LMIC striking through an economic crisis and resource constraints, Sri Lanka needs such improvements in public sector orthodontic treatment services with a rising demand to deal with future pandemics. Further, establishing facilities for tele-orthodontic services to deal with orthodontic emergencies as practiced by many countries during the pandemic (21) would be an investment for the future. Fostering public-private partnerships to secure donations from interested parties would be a viable option in this regard.

The findings of this study also indicated broader implications for orthodontic practice, not only for Sri Lanka, but for other countries as well. Sri Lanka as an LMIC endeavors to achieve pro-poor universal health coverage for orthodontic treatment services by investing on costly orthodontic treatment service as publicly funded health care. The patients who missed routine follow-up orthodontic treatment due to COVID-19 induced restrictions, now experiencing prolongation of treatment duration and less optimal treatment outcomes may need prioritized care aimed at addressing the impact of delays whilst optimizing treatment outcomes. However, overcrowded public orthodontic clinic setting influenced by resource constraints may pose many ambiguities and challenges in achieving this goal. The findings of this study therefore, add broader

implications for orthodontic practice, endeavored to accomplish universal health coverage for costly orthodontic treatment services in resource constrained, low and lower-middle-income country settings.

This study is not without limitations. The data on types and severity of malocclusions, complexity of orthodontic cases, stages of treatment, type of appliances that were used for each patient were not collected in this study which could have provided more insights into treatment approach and findings. Within the scope of this study it was not possible to explore potential delays or impact of COVID-19 pandemic on orthodontic treatment progress in comparison with number of follow up visits missed, which should be considered as a potential limitation. Further, it is not known how the female and young adult preponderance of the sample influenced the findings as gender and age can be important factors in orthodontic treatment outcomes and may limit the generalizability of the findings. Therefore, the generalizability of the findings could have been enhanced by larger sample sizes stratified for age and gender. As this study was related to retrospective reflections of orthodontic patients with regard to the orthodontic treatment that they received during the COVID-19 pandemic, recall bias could be a limitation, however, as clinical records and patients' registers were used to complement data collection this was mitigated.

The findings of this study warrant future research addressing existing aforementioned limitations to generate more conclusive evidence. Future research on implications of treatment delays, prolongation of treatment duration and less optimal treatment outcomes and complications attributed to missed follow-up visits and delayed commencement of treatment attributed to COVID-19 induced impediments would be able to generate more valid and conclusive evidence for mitigating the impact. Further, future research is warranted on the impact of COVID-19 pandemic on

normative and perceived orthodontic treatment outcomes confounded by severity and types of malocclusions, type of orthodontic appliances and increased treatment burden in the context of resource constrained publicly funded, overcrowded orthodontic treatment services.

5. Conclusions

Retrospective reflections of orthodontic patients demonstrated satisfaction with infection control protocols that were in place during the pandemic, but articulated uncertainties in achieving expected treatment outcomes due to missed appointments. Those findings were broadly in agreement of similar studies conducted in other countries to explore perceptions of orthodontic patients on impact of COVID-19 pandemic on their orthodontic experience despite our study was related to retrospective reflections of patients. Regardless of limitations, the findings of this study could help in navigating and streamlining publicly funded orthodontic treatment services amidst resource constraints, during and after future pandemics beyond Sri Lanka.

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Conflict of Interests

There is no actual or potential conflict of interests to be declared by the authors of the present manuscript.

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