

**Psychometric properties and
structural determinants of
oral care performance among
children in Australia**

by

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Declaration

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To us, health is about so much more than simply not being sick. It's about getting a balance between physical, mental, emotional, cultural and spiritual health. Health and healing are interwoven, which means that one can't be separated from the other.

Dr Tamara Mackean

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3. Nair, R., Spencer, AJ, Luzzi, L., Do, LG. The variations between states and territories in the performance of oral care delivery for children in Australia. Submitted to *Community Dental Health*.
4. Nair, R., Luzzi, L., Jamieson, L., Spencer, AJ., Do, LG. Private dental care benefits non-Indigenous children more than Indigenous children. Submitted to *Health Services research*.

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- Won the Adelaide Dental School award; 2018

2. Psychometric properties of Child Oral-care Performance Assessment Scale.

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4. Critical review of oral healthcare performance satisfaction scales.

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- Won the faculty of dentistry award; 2016

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Abstract

There are differences in the dental care system that provide services to children in Australia across its jurisdictions. The policies in these jurisdictions result in significant differences in the organisation of oral care services, the extent and eligibility for public funding, and the availability of service providers of choice. Performance of those differing systems has not been evaluated, particularly as measured in a population. Among the children, the Aboriginal and Torres Straits Islanders (Indigenous children) face a disproportionate burden of oral diseases. Further, those experiencing higher discrimination are more likely to have unfavourable dental visiting patterns. As such, the reasons for such visiting patterns are currently unexplored.

This thesis aimed to assess the effect of structural properties of the healthcare system on the performance of oral care and more specifically its role in the inequity in the performance of oral care faced by Indigenous children in Australia. The aims of this thesis were addressed through four inter-related scientific publications. The first paper that critically reviewed patient satisfaction questionnaires that assessed the performance of oral care and found 14 instruments for patient satisfaction of oral care and described its domains and assessed their psychometric properties. This critical review also found that the psychometric properties of the instruments were mostly unassessed, had differing dimensionality, and were only created for adult populations. Following this, the next paper assessed the psychometric properties of a new instrument developed for the National Child Oral Health Study (2012-'14). This 37-item instrument forms the Child Oral-care Performance Assessment Scale (COPAS) that measured the performance of oral

care among children, as reported by their parents. It was noted that COPAS had acceptable structural validity, construct validity and internal consistency. With these results, the following paper assessed the variations between states and territories in the performance of oral care delivery for children in Australia. Here the analyses found that smaller states with comparatively significant school dental services (Tasmania and South Australia) had the highest ratings for the performance of oral care, as measured using COPAS. The following paper extended this conceptualisation and assessed the effect of public versus private care on the performance of oral care and the modification of this effect based on the Indigenous status of the children. This paper found evidence of effect modification of private versus public care facilities on the performance of oral care systems with an increased chance of higher performance of oral care in private dental care facilities among non-Indigenous children versus Indigenous children in Australia.

Overall, this thesis found evidence that the major structural variabilities in Australia affect the performance of oral healthcare systems available for children and contribute to inequity in the performance of oral care for the Indigenous children.

1 Introduction

1.1 Background

In 1840, Alexis de Tocqueville noted: “The concentration of power and the subjection of individuals will increase among democratic nations, not only in the same proportion as their equality, but in the same proportion as their ignorance” (De Tocqueville 1840). This statement suggests that an informed citizenry is essential for a well-functioning democracy. Along the same lines, an Australian government report outlined a need for transparency and accountability in activities of the state and various organisational systems are essential for operationalisation of democracy to equip citizens with the required information (Murray 2008). That report by Murry A (2008) also outlined ‘Operation sunlight’ in Australia that aimed to ensure budgetary transparency, where the workings of the state were to be made accessible to non-state actors. Such transparency and accountability require well-defined quantification of the functions of the state and systems that provide services and goods to the populace. These systems include the healthcare system and as a part of it, the dental care system.

Transparency and accountability of healthcare systems require the quantification of its performance. The performance of healthcare systems is conceptually different from commonly reported health outcomes, while the attainment of desired health outcomes may play a role in the determination of its performance (Parasuraman et al. 1985). Perception of the performance of healthcare systems was speculated to arise from the gap between customer expectations and customer experiences (Gronroos 1978). Some inherent issues remain with measuring the quality of services including the intangibility of services (versus

goods); heterogeneity due to the variability across customers, service providers, and time; and the inseparability of production and consumption (Parasuraman et al. 1985).

The performance of healthcare systems (not restricted to dental care) was often assessed using patient satisfaction surveys (Almeida et al. 2015). Patient satisfaction was defined as the subjective evaluation of healthcare services and personnel (Ware et al. 1983). These questionnaire instruments that measured patient satisfaction used varying dimensions and included some instruments that assessed satisfaction as a unidimensional concept. This variability in dimensions used introduces conceptual heterogeneity. In turn, the implication of the conceptual heterogeneity is that these questionnaire instruments may not have captured the performance of healthcare systems adequately (adequacy of content validity) or with conceptual equivalence and their results may have limited comparability.

1.2 Rationale for the study

Quantification of the performance of the oral care system using an instrument with sufficient dimensionality is essential for informing citizenry and policymakers of the current state, changes over time and distributional patterns of the system. Several measures of patient satisfaction with oral care were created to quantify the performance of oral care (Nair et al. 2018; Ware et al. 1983). The earlier measures of patient satisfaction often did not have adequate theoretical and psychometric basis, and such adequacy was not quantified for oral care, as was done for overall healthcare (Almeida et al. 2015). To assess the validity of patient satisfaction instruments that measured the performance of oral care requires an assessment of the psychometric properties and dimensionality of such instruments.

The apparent unavailability of questionnaire instruments that were created explicitly to measure the performance of oral care for children and the limited testing on the available instruments that were created to measure the performance of oral care for adult populations led Do LG and Spencer AJ to create the items that measured the performance of oral care called Child Oral care Performance Assessment Scale (COPAS) (Do and Spencer 2016). These items followed the performance assessment framework outlined for Australia (NHPC 2001). A critical review of patient satisfaction instruments along with a broader overview of the methodologies applied in the field was needed to help determine the psychometric properties of this new questionnaire instrument. Following these, common measures used for the assessment of psychometric properties of patient reported outcomes were explored and confirmatory factor analyses using structural equation model was chosen as applied earlier in a similar context (Lau et al. 2009).

Structural variables are known to affect health, and in turn increase or maintain inequities in health and wellbeing (WHO 2010; Baker et al. 2018; McGrath et al. 2011). With performance of oral care as an outcome, it is important to know the structural variables that affect it (Baker et al. 2018). There are significant structural differences in the provision of oral care to children in Australia that include the organisation of oral care services, its funding sources, eligibility for public funding and availability of service providers of choice (Do and Spencer 2016). Such differences are manifest in the oral care system of Australia that varies widely between the states and territories with various mix of public and private care that are available to children in various jurisdictions (NACDH 2012). The difference in the performance of oral care that results in inequities due to the arrangement of the oral care system is mostly unassessed. One of the most prominent such differences is

the availability of public care facilities in various jurisdictions. Such inequities are especially crucial in the case of Indigenous children in Australia who face a higher proportion of disease burden (Anderson et al. 2016; Jamieson et al. 2010; Jamieson et al. 2013), and the effect of public versus private care on the performance of oral care was previously unassessed.

Thus, there are significant variations in the oral care system that include the jurisdictional variations in the oral care provision for children, and in turn effect the distribution of public and private care facilities among the children. Such variations may be a source of inequity for the Indigenous children. There are several parts of such mechanisms that are currently unexamined. These include the need for a valid measure of the performance of oral care for children that is based on adequate dimensionality and builds on previous instruments. Such instrument could then quantify the effect of living in various jurisdictions in Australia and the causal mechanism can further explore the effect of visiting private or public care on the possible inequity in oral care performance faced by Indigenous children in Australia.

1.3 Aim

The overarching aim of this thesis was to measure the parent-perceived performance of oral care services and assess the differences across the oral care services available in the Australian jurisdictions (states and territories) and among those most vulnerable to inequities in oral health (Indigenous Australians).

1.4 Objectives

1. Review the psychometric properties and the dimensions reported for patient satisfaction scales that intended to measure general oral-health care.

2. Assess the psychometric properties of the Child Oral care Performance Assessment Scale (COPAS).
3. Quantify the variations between states and territories in the performance of oral care delivery for children in Australia.
4. Assess the difference in private versus public dental care among Indigenous and non-Indigenous children.

1.5 Thesis structure

This thesis is structured as a thesis by publication. To that end, this thesis consists of Chapter 1 that provides a brief context to the work carried out in the thesis.

Chapter 2 provides an overview of the literature that relates to the measurement of the performance of oral care, the various concepts that are related to the performance of oral care. Along with it, there is also an overview of the oral care services that are available for the children in Australia. Among the children in Australia, the increased disease burden that is faced by the Indigenous children is also described there.

Chapter 3 details the methodology that was used in the four manuscripts that are contained in this dissertation.

Chapter 4 includes the publication titled “Critical review of the validity of patient satisfaction questionnaires pertaining to oral healthcare”. This manuscript critically evaluated the psychometric properties and dimensions reported for patient satisfaction scales that intended to measure general oral care that is not restricted to specific subspecialties or interventions.

Chapter 5 contains the manuscript titled “Psychometric properties of the Child Oral-care Performance Assessment Scale (COPAS)”. Here the psychometric properties of a newly developed scale were assessed using convergent validity, internal consistency and structural validity using structural equation modelling.

Chapter 6 comprises of the manuscript titled “The variations between states and territories in the performance of oral care delivery for children in Australia”. This manuscript describes the effect of living in a state or territory and how that impacts the performance of oral care among the children living in those regions.

Chapter 7 includes the publication titled “Private dental care benefits non-Indigenous children more than Indigenous children”. This study examined the differential in the effect of public versus private care on the performance of oral care between Indigenous and non-Indigenous children in Australia.

Chapter 8 provides general discussion including strengths, weaknesses and conclusions for the work that was carried out in this thesis.

The referencing style used in this thesis followed the Council of Science Editors (CSE) (8th Edition) editorial style except for the manuscripts that followed the referencing style of the journals that they are currently with. The chapters 4, 5 and 6 uses American Medical Association (AMA) reference style for Community Dentistry and Oral Epidemiology and Community Dental Health. Chapter 7 used the CSE (8th Edition) editorial style for Health Services Research. Australian English was used throughout the thesis except for the third empirical study (Chapter 7) that was written in American English to meet its journal requirements.

1.6 Significance of this study

To the best of our knowledge, this is the first study that assessed the performance of oral care for children at a national level using a theoretically adequate instrument for its measurement and assessed the effect of the variabilities in the system as well as the effect modification due to Indigenous status. The study used current causal modelling perspectives to assess two important determinants of the performance of oral care in Australia, namely the jurisdictions (states and territories) and the organisation of dental care (public versus private care facilities). It further examined the difference in the effect of public versus private care on the performance of oral care (inequity) that is faced by Indigenous versus non-Indigenous children in Australia.

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2 Chapter 2: Literature review

2.1 Measurement of healthcare service provision

Healthcare systems aim to sustain and improve the health of individuals under its care (Australian Government 2016; DoH 2016; NHS-England 2013; WHO 1950). Several measures that are distinct in their intent and the extent of their measurement are used to test the ability of healthcare systems to achieve this aim. These measures can include the measurement of access to care, adverse events that result from procedures, immediate changes in symptoms such as pain or discomfort, and changes in the quality of life or cost-effectiveness. Such measurements can be made from the perspective of the policymakers, caregivers or individuals that the healthcare system aims to serve (Drummond 2005). The ultimate test of a healthcare system is to assess the extent to which the relevant healthcare system helps the people it intends to help (Kohn et al. 2001). Healthcare systems deliver such help by providing appropriate services to the individuals and populations that require those services. Thus provided services can result in both benefits and harms to the individuals receiving them. Concerning the harms that are received by the care-recipients, the Institute of Medicine stated that there were “serious and widespread errors in healthcare delivery that resulted in frequent avoidable injuries to patients” (Kohn et al. 2000). This makes the evaluation of care provision an essential part of the healthcare system.

To enable the evaluation of care, Donabedian categorised the overall care provision system into the structure, process and outcome (Donabedian 1988; Donabedian et al. 1982). Here structure refers to the attributes of the facility where the care is provided, the process involves the provision of care and receiving it, and

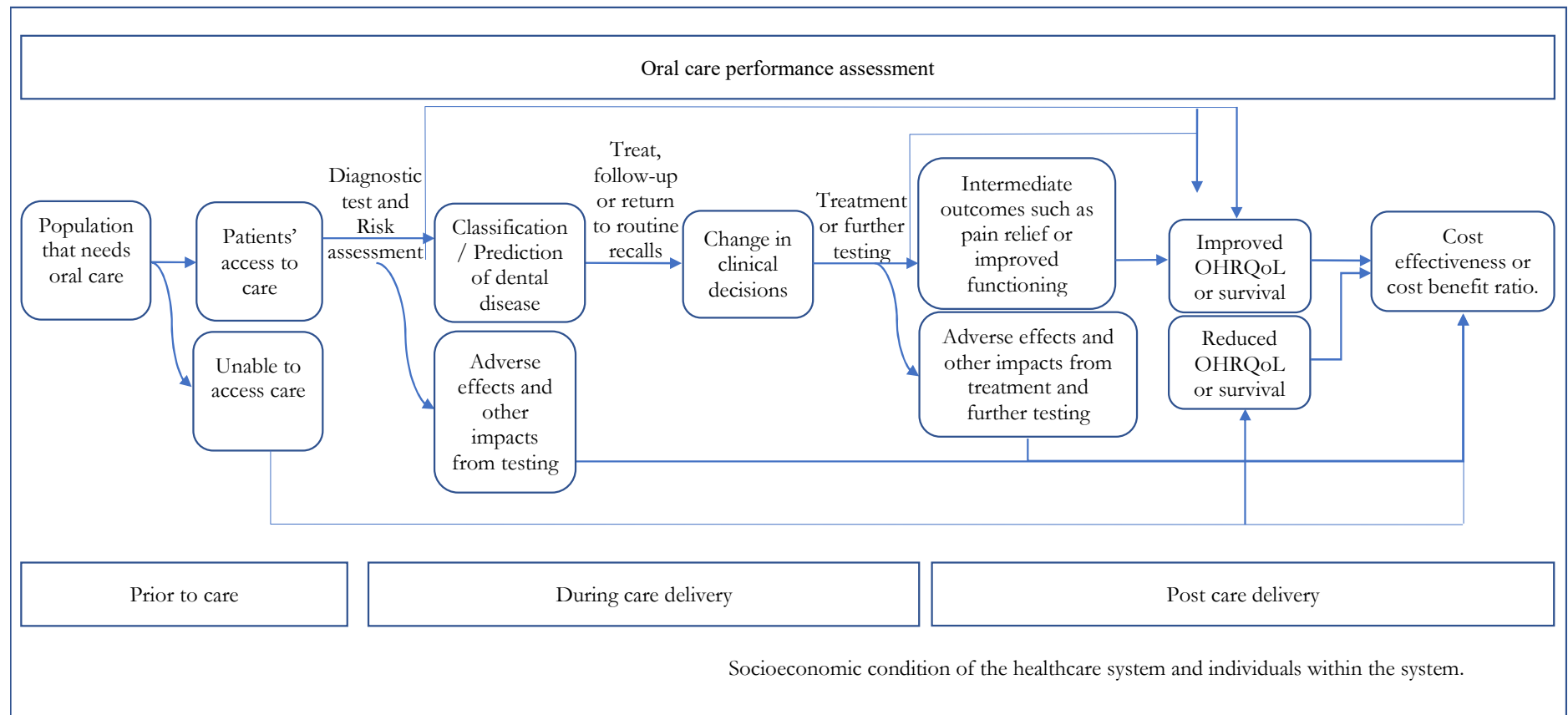
the outcome encompasses all the effects of the provision of care on the patient. The conceptual space for the performance of oral care can be illustrated using a model of the process of care provision and identifying the various measures along the continuum of care provision (Figure 1). This visualisation is an adaptation from previously related concepts for evaluation of healthcare, and care provision from the perspective of diagnostics (Grembowski et al. 1989; Harris et al. 2001; Samson and Schoelles 2012), with an overarching evaluation of all parts of the care provision that starts from the enabling access to care to maintenance of oral health in a cost-effective manner.

As healthcare systems are built to deliver the health outcomes that are needed for the people under its purview, measurement of outcomes that are reported from the perspective of the target population are essential for its evaluation (Harris et al. 2001). Structure and process, on the other hand, enable these outcomes and aspects of the structure and process are also experienced by the care-recipients. Such interactions by the care recipients with the structure and process can include the comfort provided by care facilities, the ability to physically access them, or the comfort while receiving care. Such interactions with the structure and process are also significant contributors to the overall perception of the performance of healthcare and consequently its evaluation (Donabedian 1988).

2.2 Patient reported performance of health care

In keeping with the perspective that healthcare services aim to provide beneficial outcomes to individuals under its care, quality of care was defined as “the degree to which health services for individuals and populations increase the

Figure 1: Measurement of the performance of oral care system from the perspective of a healthcare provision model.



- OHRQoL refers to Oral health-related quality of life.

- The figure describes that the performance of an oral care system spans from the proportion of population that needs care to the overall cost-effectiveness ratios attained by the overall system and parts of it. All the choices in the system are affected to various extents by the socioeconomic condition of the system and the individuals in the system.

likelihood of desired health outcomes and are consistent with current professional knowledge” (Blumenthal 1996). This is also reflected in the advocacy for patient-centred care in healthcare delivery (NHPC 2001). Patient centred care has also been advocated and discussed in the dental context (Mills et al. 2013). As individuals receiving healthcare services are the reason for its relevance, quality of care evaluated from individuals’ perspective is an integral part of the quality assessment.

Patient satisfaction measures represent one aspect of the assessment of the performance of healthcare systems (Ware et al. 1983). Ware et al. (1983) defined patient satisfaction as the subjective evaluation of healthcare services and personnel (Ware et al. 1983). Thus defined, the patient satisfaction forms an important patient reported outcome for the assessment of the performance of healthcare and is a measure of the quality of care provided. This perception of service quality was theorised to arise from the gap between customer expectations and customer experiences (Gronroos 1978).

There are some inherent issues with the measurement of the performance of services that include the intangibility of services (versus goods); heterogeneity due to the variability across customers, service providers, and differing perceptions over time. Similarly, performance of services and its perceptions suffer from the inseparability of its production and consumption (Parasuraman et al. 1985). Such difficulties were discussed in an earlier systematic review that examined patient satisfaction questionnaires in all of healthcare (Almeida et al. 2015). It noted that patient satisfaction was conceptualised and operationalised in several ways. It was also reported that there were considerable variations in the items and dimensions used by instruments that are available. This variability was related to the

questionnaire instruments in healthcare that lacked comparability, as they frequently lacked similar underlying dimensions.

2.3 Satisfaction with oral care services

Dental diseases command attention owing to their high prevalence among individuals across various age groups and countries (Kassebaum et al. 2015). These diseases require care provision to alleviate their impacts on quality of life. The high prevalence (Kassebaum et al. 2015) along with the high cost of care provision (Australian Institute of Health and Welfare and the Dental Statistics 2013; Singapore 2012/2013; Wall 2015) necessitates appropriate evaluation of oral care strategies that maximise the desirable outcomes for the overall available resources.

In dentistry, patient satisfaction was gauged as an essential measure of quality, warranting the creation of instruments for its measurement (Newsome and Wright 1999). After the creation of instruments that measure patient satisfaction with dental care, psychometric properties were often assessed, and the ensuing dimensionality was reported and discussed (Nair et al. 2018). Psychometric testing showed that patient satisfaction was a multi-dimensional concept. A systematic search identified 14 instruments that measured patient satisfaction using instruments that were targeted to measure patient satisfaction among patients who received oral care. These instruments reported a varying number of dimensions, and as such the variability in dimensions can be seen in Table 1. Here dimensions refer to various ideas that combine to form the overall scale and is identified by the interaction of a set of items and the responses from the participants (Gessaroli and Champlain 2005).

Table 1: Instruments used for measuring dental patient satisfaction and the reported dimensions.

Authors, Year	Dimensions
Koslowsky et al. 1974 (Koslowsky et al. 1974)	Personality, technical ability, office and financial
Murray and Weise. 1975 (Murray and Wiese 1975)	Economic, convenience and quality
Hengst and Roghmann, 1978 (Hengst and Roghmann 1978)	Latent hostility and general glorification
Davies and Ware, 1981 (Davies and Ware 1981)	Access, availability, pain, cost, quality and unhypothesized
Corah et al. 1984 (Corah et al. 1984)	Information communication, understanding-acceptance, technical competence.
Chapko et al. 1985 (Chapko et al. 1985)	Dentist-patient relations, technical quality of care, access, patient waiting time, cost, facilities, availability, continuity, pain, auxiliaries perform expanded duties, staff-patient relations, staff technical quality and office atmosphere. 13 dimensions.
Reifel et al. 1997 (Reifel et al. 1997)	Access, Communication and Quality
Stewart and Spencer. 1994 (Stewart and Spencer 1995)	Communication, services received and their results, staff and waiting time, clinic location and appointments, and conceptually unrelated items.
Stewart and Spencer. 1995 (Stewart and Spencer 1996)	Communication, services received and their results, staff and waiting time, clinic location and appointments, Dental professional, affordability, and conceptually unrelated items.
Chaffin et al. 2007 (Chaffin et al. 2007)	Belief about care and environment.
Imanaka et al. 2007 (Imanaka et al. 2007)	Treatment, communication, facility and appearance.
Perera and Usgodaarachchi. 2009 (Perera and Usgodaarachchi 2009)	Clinical environment, treatment process, outcome of care and cost of care

Such dimensionality often came from exploratory factor analyses and the dimensions were varied among these instruments (Table 1). The number of dimensions reported in these studies (n=12) ranged from 2 to 13, with a majority of the studies (n=9) reporting 2 to 5 dimensions. There were several common concepts among the dimensions and items within those dimensions. These common concepts pertained to the dental office, dental personnel, treatment and treatment-related cost. The concepts related to structural factors of the dental clinic included access and comfort. The concepts related to dental personnel mainly included communication and other interpersonal interactions. Treatment-related items generally pertained to the quality of care and comfort during treatment. Finally, the cost was a part of all instruments that were made for populations that primarily relied on private funding. Two exceptions to the inclusion of cost were those reported by Hengst and Roghmann (1978), and Stewart and Spencer (1995) (Hengst and Roghmann 1978; Stewart and Spencer 1995); though the latter included the cost in a follow-up version of the instrument (Stewart and Spencer 1996). Though there were conceptual similarities, there were significant differences in the contents of items between the included instruments.

Due to the multidimensionality contained in the concept of patient satisfaction, multi-item questionnaires are required for adequately assessing it. The relevant domains for these instruments in oral health were often adapted from pre-existing instruments in overall healthcare such as the Medical Satisfaction Questionnaire and the Medical Interview Satisfaction Survey (Corah et al. 1984; Davies and Ware 1981). Thus, oral healthcare with its mostly service-oriented approach had used patient satisfaction surveys with varying conceptual dimensions that were based on prior instruments in medicine (Chaffin et al. 2007; Chapko et al. 1985; Corah et al.

1984; Davies and Ware 1981; Hengst and Roghmann 1978; Imanaka et al. 2007; Koslowsky et al. 1974; Murray and Wiese 1975; Perera and Usgodaarachchi 2009; Reifel et al. 1997; Stewart and Spencer 1995; 1996). Other than the differing dimensions present in these instruments, there were also significant differences in the conceptualisation of patient satisfaction for questionnaire construction, where some of the instruments measured the overall healthcare perspective and others measured satisfaction for a specific visit (Pascoe and Attkisson 1983).

When confronted with heterogeneity in the theoretical basis and content, it is pertinent to evaluate their psychometric validation to assess the extent to which these instruments were measuring what they intended to measure. Previous studies suggest that there were limited pretesting procedures, and a large proportion of the instrument were developed using expert opinion (Table 2). These instruments were assessed for their internal consistency and then their factor structure using exploratory factor analysis for all but one study that also included confirmatory factor analysis (Perera and Usgodaarachchi 2009).

The included dimensions and items in these instruments depend on the theoretical basis for the measurement, and appropriate theoretical basis is required for the instruments remain content valid (Mokkink et al. 2010). From this perspective, the included instruments were developed with differing theoretical bases. Some of these theoretical bases were as simple as disconfirmation of expectations that did not include conceptualisation of the domains that need to be measured, while others gave guidance on the domains that need to be included. Even in cases where the domains were given, they were often based on a review of prior instruments that were available. With this heterogeneity in the theoretical basis and a general lack of inclusion of patient perspectives may indicate lower content validity among the

patient satisfaction instruments for oral care. An exception to this trend was a study that used focus groups and Delphi technique for assessing content validity, where four experts were involved in the consensus building for the content of this instrument (Perera and Usgodaarachchi 2009). However, the details of the methods were not provided, and thus the extent of its implementation remains unascertainable from that publication alone.

Measures of reliability were not reported for almost all studies. This meant an absence of adequate quantification of the amount of variation between interviewers, where interviewers were used. Similarly, there were no reports of stability of scores over time, except one study that reported the percentage of change in a two-week period (Stewart and Spencer 1995). Besides reliability, none of the instruments reported on absolute measurement error or responsiveness.

Table 2: Development and testing of dental patient satisfaction instruments, as reported in their initial publications.

Authors, Year	Sample included	Prior instrument	Number of items	Pretesting (n); procedures	Item selection (n)	Internal consistency	Structural validity (n)
Koslowsky et al. 1974 (Koslowsky et al. 1974)	Patients- Dental clinic USA	De novo	20	Yes (89); Alternate form reliability	Expert judgement	Alpha (428) ($\alpha=0.89$)	None
Murray and Weise. 1975 (Murray and Wiese 1975)	Patients - dental clinic USA	De novo	15	Yes (24) Split half reliability	Expert judgement		EFA (40)
Hengst and Roghmann, 1978 (Hengst and Roghmann 1978)	Mothers on welfare USA	De novo	12	Yes (200); Split- half reliability (Rho=0.68)	Expert Judgement		Model fit and EFA (240)
Davies and Ware, 1981 (Davies and Ware 1981)	General population USA	PSQ	19	None	Expert judgement	Alpha (0.81)	EFA (3209)
Corah et al. 1984 (Corah et al. 1984)	Patients- Dental clinics USA	MISS	10	None	Expert judgement	Alpha (0.92)	EFA (105)
Chapko et al. 1985 (Chapko et al. 1985)	Patients- Dental clinics USA	DSQ, Hengst and Roghmann, and De novo	42	None	Expert judgement	Alpha	EFA (7202)

Stewart and Spencer. 1994 (Stewart and Spencer 1995)	General population- Australian adults Australia	PSQ III, DSQ, MSMC	24	None	Expert Judgement	Alpha (0.88) / retest reliability	EFA (1903)
Stewart and Spencer. 1995 (Stewart and Spencer 1996)	General population- Australian adults Australia	PSQ III, DSQ, MSMC	31	None	Expert Judgement	Alpha (0.89)	EFA (576)
Reifel et al. 1997 (Reifel et al. 1997)	Patients- Indian Health Service USA	De novo	11	None	Expert judgement	Alpha (0.88-0.93)	None
Chaffin et al. 2007 (Chaffin et al. 2007)	Patients- US Military USA	De novo	11	None	Expert judgement	Alpha (0.95)	EFA (309261)
Stalnacke 2007 (Stalnacke 2007)	General population- 50 year olds Sweden	De novo	8	None	NA	Alpha (0.81, 0.54)	EFA (5363)

Imanaka et al. 2007 (Imanaka et al. 2007)	Patients- Dental School clinic Japan	De novo	23	None	Expert judgement	Alpha (0.95, 0.92, 0.86, 0.89)	CFA (3394)
Shrestha et al. 2008 (Shrestha et al. 2008)	Clinic patients India	De novo	9	None	Expert judgement	Alpha (0.75)	None
Perera and Usgodaarachchi. 2009 (Perera and Usgodaarachchi 2009)	General population Sri Lanka	De novo	22	Focus group (30)	Face validation (30)/ Delphi (4)	Alpha (0.91)	EFA (117)

*PSQ- Patient Satisfaction Questionnaire, DSQ- Dental Satisfaction Questionnaire, MISS- Medical Interview Satisfaction Scale,
MSMC- Measurement of Satisfaction with Medical Care

2.4 Performance of oral care

There are several common outcomes such as oral health-related quality of life, and willingness to pay that are available and appropriate for measurement of the outcomes for specific interventions or programs (Locker and Allen 2007; Tan et al. 2017). Healthcare satisfaction surveys can measure the performance of oral care more broadly (Almeida et al. 2015; Ware et al. 1983), where they can include all aspects of healthcare provision including structures, processes, and outcomes (Donabedian 1988; Stewart and Spencer 1996). Thus, the instruments that measure the satisfaction with oral care aim to measure the overall performance of care provision (Figure 1). From the perspective of healthcare evaluation, healthcare satisfaction surveys were defined as a patients' subjective assessment of the performance of services and personnel that deliver the appropriate care (Ware et al. 1983). As the evaluation of healthcare systems can occur either at the level of individuals or for the overall healthcare systems, appropriate measures may enable the quantification of the distribution and the quality of care provision in a healthcare system. This thesis distinguishes between satisfaction with care, quality of care, and performance of care. When using patient reports of the personnel and facilities, these three can be very similar. Here the satisfaction with care refers to patient reports based on instruments whose domains are not theoretically comprehensive to measure the overall performance of care. Quality of care also differs from the performance of care by making a qualitative assessment of care, rather than assessing comprehensively the performance of care according to its dimensions.

The general lack of consensus on the required dimensions for evaluation of oral care satisfaction was similar to that found in overall healthcare (Almeida et al.

2015). Such uncertainty related to the required dimensionality arises from the limited theoretical framework that guides the required dimensions for item development. A theoretical framework that encompasses the performance of care was conceptualised in the National Health Performance Framework (NHPF) for Australia's healthcare system, and it consisted of nine dimensions (NHPC 2001). The NHPF included nine dimensions which were Effective, Appropriate, Efficient, Responsive, Accessible, Safe, Continuous, Capable and Sustainable. Each of the dimensions was elaborated such that they could be used to develop indicators for the measurement of the performance of healthcare provision. It aimed to enable the measurement of performance of healthcare for all of Australia and specific subpopulations within the country. Succinct versions of the content that were proposed to encapsulate the concept within each dimension as would be pertinent to the elucidation of the performance of oral care from the perspective of the care-receiver (Table 3).

Table 3: Dimensions in the performance of oral care and the content area within each that relates to the performance of oral care from the perspective of the care-receiver (NHPC 2001).

Dimension	Content area
Effective	Achieving the desired outcome.
Appropriate	Was it relevant to the care-receiver's need?
Efficient	Achieving the desired results with the highest cost-effectiveness
Responsive	Provision of care-receiver oriented service that includes dignity, confidentiality, participation in choices, promptness, quality of amenities, access to social support network, and choice of provider.
Accessible	Receive care at convenient location and time, without facing inequities.
Safe	Limit potential harm.
Continuous	Uninterrupted and coordinated care.
Capable	Services based on skills and knowledge.
Sustainable	Provision of workforce, equipment and facilities.

As was illustrated in Figure 1, the dimensional framework provided by NHPF concurs that the outcomes of healthcare provision are but a part of the evaluation of healthcare. This is also in line with the conception of healthcare evaluation described by Donabedian (Donabedian 1988), and the dimensions found in NHPF are similar to frameworks found in other regions as well (Hibbert 2013). Theoretical frameworks enable the development and validation of the overall quality of oral care provision with adequate dimensionality. Though such frameworks are available for the overall assessment of healthcare performance, this has not been used for the measurement of the performance of oral care. Multidimensionality and latent nature of healthcare satisfaction require testing of psychometric properties that quantify their measurement properties and dimensionality (Chaffin et al. 2007; Chapko et al. 1985; Corah et al. 1984; Davies and Ware 1981; Hengst and Roghmann 1978; Imanaka et al. 2007; Koslowsky et al. 1974; Murray and Wiese 1975; Perera and Usgodaarachchi 2009; Reifel et al. 1997; Shrestha et al. 2008; Stahlacke 2007; Stewart and Spencer 1995; 1996).

2.5 Structural determinants of inequity and health disparities

In the previous definition of structure by Donabedian, it assessed the process of care and divided it into structure, process and outcome (Donabedian 1988). In the case of the determinants of inequity, the structural determinants are used from a different perspective (WHO 2010). Here structural determinants include social, economic and political context that interact with social hierarchy and then determines the socioeconomic position. In this model, socioeconomic position in turn is mediated by the social determinants of health and then impacts the equity in health and wellbeing. Assessments of inequity and its structural determinants was

conceptualised and reported in the oral health context (Baker et al. 2018; Batchelor 2017; Newton and Bower 2005; Schwendicke et al. 2015). Here inequity in health refers to systematic, avoidable and unfair differences in health outcomes or its determinants between groups of individuals (Penman-Aguilar et al. 2016).

Appropriate performance of oral care is important for limiting the impacts of oral health on quality of life and to prevent future disease (Brennan et al. 2012; Locker and Jokovic 1997; Slade 1998). Its variations can result in inequitable distribution of services required by populations under its care. These variations can also result in inequitable distribution of oral health status. As a determinant of oral health and quality of life, the performance of oral care and its equitable distribution represents one of the important outcomes related to oral health.

2.6 Oral health in Australia

The prevalence of dental diseases is high among Australian children (Armfield et al. 2009; Do and Spencer 2016). This prevalence is mostly attributable to dental caries. In Australia, the prevalence of dental caries (52-58%) among six-year-old children was reported to be more than four times as high as that for asthma (12%), which is another common disease in childhood (AIHW 2009). The disease burden that results from dental diseases impacts the lives of children (Do and Spencer 2007; Sheiham 2006). Irreversible nature of dental diseases has the potential to change their oral health for the rest of their lives.

Several interventions at individual and societal levels are used to prevent or mitigate the effects of dental diseases among children in Australia (Do and Spencer 2015; Jepsen et al. 2017). These include water fluoridation, the use of fluoridated toothpaste and other professional products, maintenance of dental hygiene,

appropriate food intake and visits to dental professionals. Among these, professional care uses a large amount of resources (Australian Institute of Health and Welfare and the Dental Statistics 2013). Professional care can be especially vital for children, as interventions such as the use of fluoride varnish and silver diamine fluoride can provide risk reduction among children who may be at high risk for dental caries (Marinho 2009; Oliveira et al. 2019; Yee et al. 2009). With training for effective prevention strategies and appropriate care-provision, care providers can play an essential role in reducing the impacts of dental diseases on the children's well-being. The long-lasting repercussions of common dental diseases along with the preventable nature of these diseases demand greater efforts for tackling this societal challenge (NACDH 2012).

There is considerable variability between the dental care provision systems in the various states and territories that differentially prioritise between school-based dental care, public dental services, and other facilities (Do and Spencer 2016). This owes mainly to the varying amount of funding from the state and territories directed towards the oral care of children (NACDH 2012). Such heterogeneity includes the availability of school dental services (SDS), the provision of care for children through community dental services (CDS), the proportion of children who can access these public dental services, overall funding for the public dental services, co-payments and number of locations for public care facilities (NACDH 2012). With variation in funding for dental services, there are quantifiable variations in the proportion of children who visit public or private dental services perpetuated by Commonwealth funding (central funding for all of Australia) flowing to either public or private services depending on choices made by parents. That choice is influenced by the availability of public dental services (SCARC 1998). The experience of care provision is widely

different for those at differing levels of socio-economic positions depending on the availability of public insurance and possession of private health insurance versus those with no insurance. Currently, New South Wales, Victoria, and Australian Capital Territory operate minimal school dental services. Instead, these jurisdictions operate community dental services with different child population coverage. The other Australian states operate school dental services to varying degrees (Murnane 2012). The availability and amount of co-payment and services are also different for the various regions (MFHA 2017). The impact of such variability among the systems in the various states and territories in Australia and its effect on the performance of oral care for children is currently unassessed. A valid measure of the performance of oral care for children is necessary to evaluate the impact of such variability in dental service provision in the various regions of Australia on service utilisation, the quality of the rendered services, and the dental health outcomes.

With such a heterogeneous system, the evaluation of care provision is essential for planning professional oral care provision. Such evaluation is essential, not only because of the occurrence of widespread omission of effective care options, other errors, and injuries that are avoidable (Kohn et al. 2000), but also the possibility of overdiagnosis and provision of inappropriate care (Nair and Ai-Min 2015; Williams 1988).

2.7 Public versus private care

Systems that provide health care are resource intensive, with resource allocation organised in a myriad of ways (AIHW 2016; Scott 2001; Wall 2015). Resource allocation involves an assertion of the constituents who will pay for the care provision and those who will receive it (Williams 1988). A broad categorisation

of such care delivery can be divided into those receiving public or private funding; the latter can often be through private insurance. In both private and publicly funded care, the group receiving care may not include those who pay for it. A majority of the spending on oral care in Australia occurs in the private sector (AIHW 2016). The oral care for children is an exception, with a more substantial proportion of public spending. In the context of oral care for children in Australia, Commonwealth funding (funding from the Federal Government) is passed on to the states and territories, who in turn have the discretion to use such funding to provide public dental care for children (NACDH 2012). This has resulted in a heterogeneous arrangement of oral care for children. A large amount of the heterogeneity results from differences in the extent of public care that is available in each of these regions.

Donabedian summarised the political philosophies around private, public and mixed models in healthcare in vaguely libertarian and egalitarian perspectives (Donabedian 1971). In the case of the egalitarian system, there is usually a need to limit demand (Williams 1988). While in the libertarian system, there is often a need to curtail oversupply. In the case of mixed strategies, a combination of private and public funding systems aims to provide the necessary care. These mixed systems often lack clear reasoning for demarcation of what is included in the public and private care services, and the overall population or specific sub-groups may not benefit from some demarcations versus others. Thus, the optimisation of efficiency in the mixed system needs to be balanced with positive outcomes for the people under its care (Gilson 1998).

While assessing the perceived quality of care, a higher expectation of quality for private care has been reported (Camilleri and O'Callaghan 1998). However, the pre-supposition that there is a better quality of care due to higher efficiency or

effectiveness in the private sector may not be true (Basu et al. 2012). Both the public and the private care services come with unique drawbacks that need to be assessed for each situation (Roberts et al. 2000; Scott 2001; Williams 1988). Though mixed systems can benefit from synergies between coexisting public and private systems, the two systems could also interact in ways that can negatively impact each other (Tuohy et al. 2004). In Australia, the increase in the number of private care facilities has not always resulted in synergistic improvements in patterns of utilisation of care (Sundararajan et al. 2004).

The percentage of dental care expenses covered by public services in the European Union was linearly related to missing dental visits (Elstad 2017). There the percentage of public expenditure for dental care ranged between 0 to 65% in various jurisdictions. In 2013, the Australian public spending on dental care accounted for 25.4% of the total spending on dental care (AIHW 2015). Approximately 60% of the children aged 5-14 years visited public clinics. Prior studies that have assessed the performance of the oral care services have used proxies such as missed appointments or inadequate appointments. Such items do not examine the care provision system adequately. Our current literature review suggests that there is a lack of studies that report on the differences in care provision between private and public dental care visits among children.

2.8 Inequity in the performance of oral care: Aboriginal and Torres Strait Islanders

A lack of studies evaluating the performance of oral care is even more critical among the Aboriginal and Torres Strait Islanders (Indigenous Australians) who face numerous health inequities (Anderson et al. 2016). They are a marginalised community that face racial discrimination due to colonisation and the resulting

disenfranchisement of their land and culture. Indigenous Australian children, who generally experience greater discrimination, are less likely to have visited a dentist (Jamieson et al. 2013). They are also more likely to have had dental extractions and to have undergone dental procedures under general anaesthesia than their non-Indigenous counterparts (Jamieson et al. 2010). Similar inequities are faced by Indigenous populations in various Australian jurisdictions, with measuring the levels of inequities a vital principle of the 'Closing the Gap' initiative (Anderson et al. 2016; Tiwari et al. 2018). It is imperative to identify the structural causes of inequities that can help Australian states and territories plan their healthcare systems more equitably. Thus, there is a need to study the effects of the structuring of the oral care service and assess its effects on the performance of oral care, and more importantly the role it plays in the inequity faced by Indigenous children in Australia.

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3 Methods

This chapter describes the methods used in all the publications that make up this thesis. The publications include a critical review and three empirical studies. The first study was a critical review that assessed the psychometric properties of previously published instruments that measured patient satisfaction for oral care, while the three empirical studies used data collected in National Child Oral Health Study (2012-14) (Do and Spencer 2016).

3.1 Critical review

Critical review of the validity of patient satisfaction questionnaires pertaining to oral health care.

The first publication aimed to critically review the validation process of oral healthcare satisfaction scales measuring general oral care. The following steps were taken to accomplish this aim: Patient satisfaction was defined, inclusion-exclusion criteria were developed, relevant searches were carried out, articles were screened, relevant references were searched, and the finally included articles were critically evaluated. This study operationalised the earlier definition of patient satisfaction by Ware et al. (1983) (Ware et al. 1983). Thus, the included instruments were the ones that assessed healthcare services and personnel from a subjective care-recipients' or their caregivers' (such as parent or guardian) perspective. COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) was used to assess the extent of reporting by the included measures (Mokkink et al. 2010). COSMIN was used here, as it was the consensus checklist to

assess the measurement properties among health-related patient reported outcomes.

3.1.1 Inclusion/Exclusion criteria

Publications in the English language were included when they detailed multi-item patient satisfaction questionnaire of general oral care, as reported by patients or the population serviced by the appropriate healthcare system. Here general oral care refers to overall oral care not restricted to those for specific treatments or sub-specialties in dentistry. Included instruments measured as a scale or index with at least a simple additive score reflecting the patient satisfaction with general oral care. Questionnaires that used a single item or a global question for measurement of patient satisfaction were excluded. Instruments with no psychometric validation were also excluded. Similarly, questionnaire instruments that aim to measure the satisfaction of specific treatments were excluded.

3.1.2 Search strategy

Based on the aim and the inclusion/exclusion criteria, preliminary searches were carried out to scope for relevant search terms. It was then decided to include terms related to patient satisfaction, dentistry, and questionnaires. With this strategy, search terms were built with the help of the research librarian for both PUBMED and EMBASE. The search results were extracted and imported into Endnote X 7.5©, and duplicates were removed. Complete list of search terms is provided in Chapter 4. All the identified publications were assessed for inclusion by screening title and abstract (RN). The publications that matched the inclusion or exclusion criteria or were uncertain based on the title and abstract were separated. A subset of 40 articles was extracted and a second reviewer (SI) reviewed them to check for the implementation

of the inclusion-exclusion criteria. All disagreements were discussed and resolved. Full-text of this set of articles were then downloaded and further assessed for inclusion.

3.1.3 Data extraction and assessment of validation

Data relevant to the validation of patient satisfaction surveys were extracted but was limited to the most common information that was available in the included publications. Where possible, the following data were extracted: dimensions in the instrument, sample and setting, source of items, number of items, pre-testing procedures, item selection criteria, internal consistency, and structural validity. The assessment of validation was carried out using the general guidelines that were published for assessment of the measurement properties of instruments (COSMIN) (Mokkink et al. 2010). Here the aspects of the primary validation studies that are of interest include internal consistency, test-retest reliability, measurement error, content validity, structural validity, hypothesis testing, responsiveness, interpretability, and generalizability. For the instruments that were carried out after the primary validation and applied in dissimilar scenarios, cross-cultural validation and the necessary adaptation were considered more relevant than other aspects of validation. The reporting of the findings based on the COSMIN checklist was focussed on the commonly reported measures and outlined the ones that were missing, as many of the studies missed several analytics and procedures that assess their measurement properties. Not all the measurement properties were expected to be published in the same document, and thus the information from secondary studies was also examined for completeness of the assessment.

3.2 Empirical paper 1

Psychometric properties of the Child Oral-care Performance Assessment Scale (COPAS).

This publication aimed to report the psychometric properties of the newly developed instrument: COPAS. To enable this, the data for this study were drawn from the National Child Oral Health Study (NCOHS) 2012-2014 (Do and Spencer 2016). A two-stage stratified random sampling procedure was used to draw a representative sample of Australian children aged from 5 to 14 years. This sample included children from all Australian states and territories, and the recruitment of children was carried out from primary and secondary schools.

To draw a representative sample of children from the target population, a two-stage stratified sample design was implemented within each state and territory. In the first stage, a sample of schools was selected from a sampling frame of all schools located within each jurisdiction created from a list provided by each jurisdiction which included all public, Catholic and independent primary and secondary schools.

To achieve a good representation of schools, the sampling frame was first split by region and then by primary vs secondary or combined school and then sorted by a composite index of either school or area socioeconomic status. These were the Index of Community Socio-Economic Advantage (ICSEA) (ACARA 2013) or Socioeconomic Index for Areas (SEIFA) score (ABS 2001). Schools were then selected with a probability proportional to size of enrolment.

In the second stage a cluster of children was randomly sampled from each participating school. Children were oversampled to accommodate non-response or

refusal to participate. Invitations to parents were distributed through schools, for their child to participate in the study. Activities were undertaken to encourage participation. Only children whose parents provided signed, informed consent for their child to participate were included in the study. Questionnaires containing COPAS and other variables were provided to the parents, who then self-completed them. Further details about the study protocol can be found in an earlier publication (Do and Spencer 2016).

3.2.1 Item Development

The items of the COPAS were developed *de novo* by Do LG and Spencer AJ. The objective of this process was to develop a multi-item instrument to collect parental observation regarding the assessment of dental care received by their child. This process followed the standard practice as below.

The theoretical framework adopted in developing the dental system performance items was based on the Health System Performance domains from the National Health Performance Framework (NHPC 2001). These domains are Effective, Appropriate, Efficient, Responsive, Accessible, Safe, Continuous, Capable and Sustainable. These nine domains cover the most important aspects of a dental care system.

The researchers first developed a list of potential items under each domain by consensus. The wording of each item was refined through discussion and consultation with external researchers. A small convenient group of laypersons who had a recent dental visit was invited to test the items. A research assistant conducted further interviews with those laypersons. Further discussion reduced the number of items per domains to a minimum of four.

All 38 items and a global rating of the dental visit were included in a parental questionnaire completed by 108 school children in Queensland (Qld). Those children also underwent a dental examination. A preliminary analysis of psychometric properties of the questionnaire was conducted using data of those children. Internal consistency and convergent validity of the questionnaire were acceptable. Therefore, the questionnaire had been accepted for use in the NCOHS.

3.2.2 Data analyses

Data were checked and cleaned to ensure acceptable accuracy. The responses to the 38 items of COPAS were in the form of a bipolar rating scale that ranged from strongly disagree through neutral to strongly agree, with a summative Likert scale of the relevant items (Appendix 1). Items 13, 17, 19 and 20 of COPAS were reverse coded, owing to their negative wording. Item 22 and 27 asked about the child feeling at ease in a clinical situation. So, for parsimony, ease of interpretation of the domains and better model-fit, item 22 was removed from the two scales. Six items contained “Not Applicable” (NA) as an option. These were mostly items that pertained to the continuity of care. Two scales were conceptualised; COPAS that contained 37 items and COPAS-partial that contains items other than those with NA as the option with a total of 31 items. Distribution of item responses was checked individual items, the proposed domains, and the scale totals. To check the stability of the model, cross-validation of the model was performed in a random split sample (Pohlmann 2004). Data were split into five validation groups for cross-validation of the factor structure. The split was accomplished with a blocked random selection with a block size of five, resulting in five equal sized groups.

Data were analysed using SPSS 24 and STATA 14. Internal consistency was assessed using Cronbach’s alpha. These were calculated for the relevant domains

and overall scales. Convergent validity was assessed by analysing the correlation between the domains and overall scales with a global question that measured satisfaction with overall oral care. This correlation was quantified using Pearson's correlation coefficients. A priori assumption was that there would be weak to moderate correlations, as the single question lacks the adequate dimensionality that a multi-item questionnaire can achieve. Structural validity was assessed using Structural Equation Modelling (SEM), which uses confirmatory factor analysis as its measurement model (Kline 2015). Structural validity assessed the nine dimensions in COPAS (Effective, Appropriate, Sustainable, Efficient, Accessible, Responsive, Safe, Capable, Continuous) and COPAS-Partial (All the dimensions excluding Continuous). These models should reflect the nine dimensions from the theoretical model for COPAS and eight dimensions for COPAS-Partial. These dimensions were the ones outlined in the National Health Performance Framework (NHPC 2001).

A model was built on the main validation group (one among five that were made for cross-validation). The full-information maximum likelihood estimation that accounted for missing values was used. Convergence of the models was sought, the fit was assessed, and parsimonious models were sought. Model fit was assessed using root mean squared error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis index (TLI), and coefficient of determination (COD). RMSEA less than 0.08, CFI and TLI less than 0.9 and COD greater than 0.95 were ascertained as having adequate fit, though these were not considered inviolable limits (Kline 2015). After the model-fit and parameters were ascertained, cross-validation was sought by assessing structural invariance across the five validation groups (Gregorich 2006). Here, structural invariance refers to a lack of significant

differences in the factor loading among the models created in the five validation groups. Alpha for the assessment of structural invariance was set at 0.05.

3.3 Empirical paper 2

The variations between states and territories in the performance of oral care delivery for children in Australia.

With substantial differences between the states and territories in the provision of oral care and an absence of prior appropriate measurement instruments or datasets, there are no prior reports of measuring the performance of care among children across the states and territories in Australia. Such measurement is essential to understand whether the care provision is meeting the expectations of the population that it aims to serve. Thus, this study aimed to evaluate variations across state and territories in the performance of oral care delivery for children in Australia, as reported by their parents. This study used data from the National Child Oral Health Survey (NCOHS) 2012- 2014 (Do and Spencer 2016).

The COPAS score was calculated by adding the score from all the responses while allowing three missing responses for individual items. The total score can vary between 0 to 148, and a higher score indicated a better performance of oral care. COPAS reported an internal consistency using of 0.95. The validity of COPAS was assessed using structural equation models, and this reported adequate model fit using root mean squared error of approximation, comparative fit index, Tucker-Lewis index, and coefficient of determination. There was also adequate convergent validity with the overall rating of oral care, as reported by an item measuring oral care

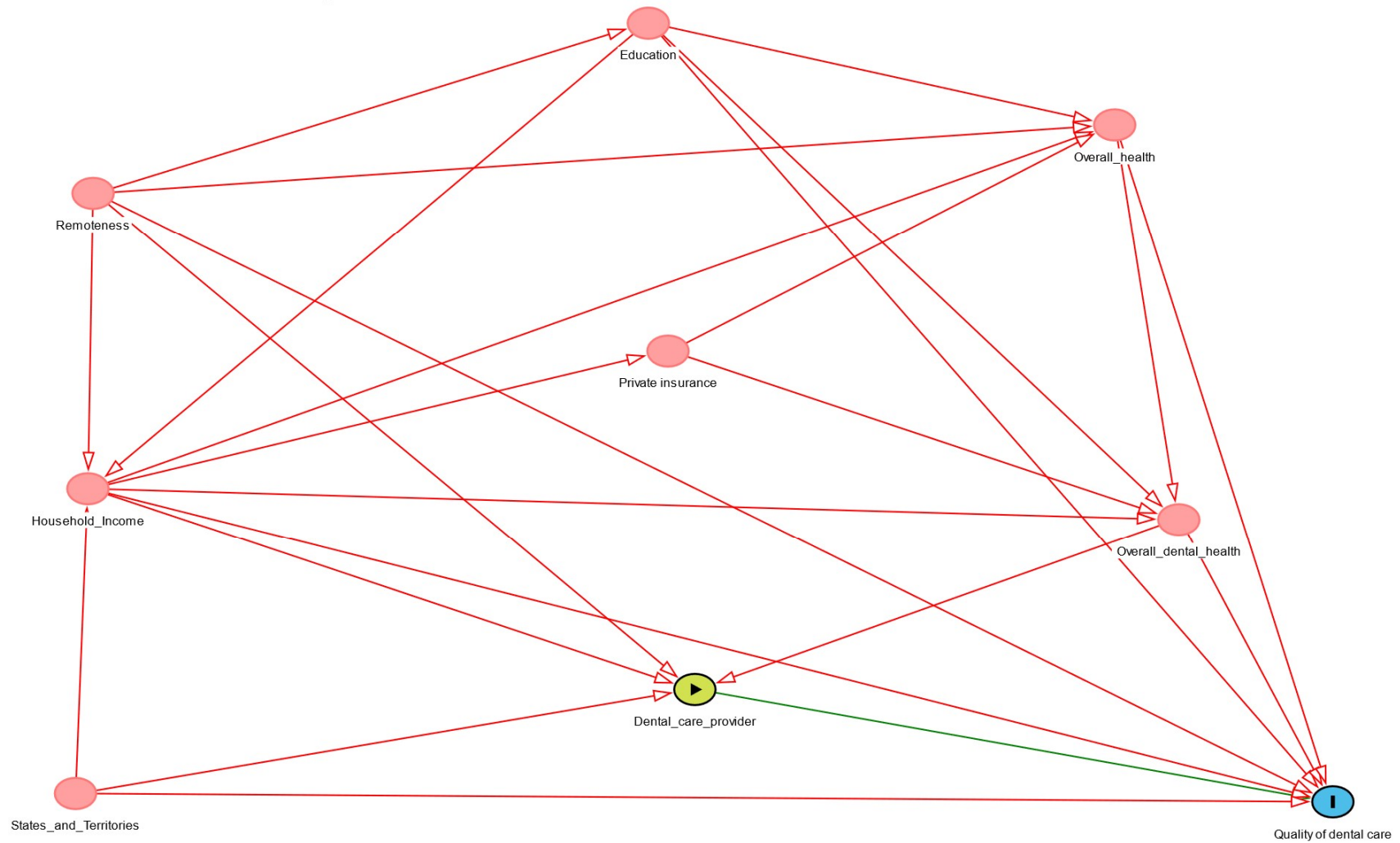
provision ($\rho=0.59$). An overall rating of last dental visit was measured using a 5-point rating scale that ranged from Excellent to Poor.

3.3.1 Data analyses

Descriptive statistics were estimated for variables that were commonly related to satisfaction with oral care. These estimates were calculated while accounting for the hierarchical structure of the data and the sample weighting. The descriptive statistics included age, gender, equivalised total household income, remoteness and visit to a public care facility. Here the statistical models were aimed to assess the variation at state or territory level in overall score for COPAS and its dimensions separately. From a causal perspective, the total effect of being in a state was considered as the exposure and the outcome was COPAS. As such, there is a negligible chance of confounding bias for this relationship from demographic or health-related variables, as these demographic and health-related variables have a negligible chance of causing the exposure (states and territories). The effect of being in the state or territory is hypothesised to pass on through multiple mediators that may include many of the demographic and health-related variables along with possible interactions and effect modification (Figure 2). This conceptualization of the other variables not affecting bias was similar to its approach in prior research (Sanders et al. 2009). Apart from the causal consideration, there is also the relevance for the oral care system (influenced by the administrative agency of the states and territories) being suitable for the people whom it aims to serve. Thus, adjusting for mediators would change the policy relevance of the analyses.

Of the overall sample, 15941 respondents with valid responses for COPAS were included in the analyses for COPAS. This shrinkage in the number of respondents was expected, as previous studies that assessed care from overall

Figure 2: Directed acyclic graph outlining the relationship between the residence in a state or territory and the mediation by various other factors.



populations show that many children do not have adequate experience with care. This could result in their parents not responding to questions related to care provision for their children (da Silveira Pinto et al. 2016; Wang et al. 2016). To assess for the effect of missing data, the demographic variables (accounting for complex sample and weighting) were compared for both the overall group and the sample included in the analyses here. Those with valid responses were found to be similar to the overall group. To further verify the results using another measure, the global rating of oral care (n=20971) was also modelled. Here mixed effects models (ordered logistic regression) were used to calculate the odds ratios. Mixed effects models using `meglm` command in STATA 14 (Gaussian, identity link) were used that account for the strata that the individuals were a part and sample weights were applied (Rabe-Hesketh and Skrondal 2006). The states and territories were also assessed with the dimensions that make up COPAS using similar models. SA was used as a reference category for the overall model for Australia, since the early descriptive statistics suggested that it may have the highest average COPAS score. Separate models were used with each of the nine dimensions of COPAS. Analyses were carried out using SPSS 24 and STATA 14.

3.4 Empirical paper 3

Private dental care benefits non-Indigenous children more than Indigenous children.

The inequities that are faced by Indigenous Australians (Aboriginal and Torres Straits Islanders) are well documented, but the mechanisms that enable these inequities are unknown from the perspective of oral care systems. To enable this

assessment, the effect modification on the effect of private versus public care on COPAS due to Indigenous status was assessed in this paper.

Data was sourced from the National Child Oral Health Survey (NCOHS) 2014 (Do and Spencer 2016). The sampling technique was intended to reflect the overall Australian child population and the population in each state and territory. To this end, the sample was weighted to adjust for response bias. The weights were based on both child and family characteristics that reflects national and state-level demographics.

In this study, the type of clinic used for the last dental visit by the participating child was reported by the parent or guardian. Public clinics included school dental services, public hospitals and community health clinics. While private clinics included private dental clinics and private health fund clinics. Among the respondents, 2624 reported that they didn't know, or the question was not applicable to them. Data from these participants were not included in this study. The outcome of interest was the quality of the performance of oral care as measured using COPAS. Among the participants, 15,941 respondents had valid COPAS scores. These participants were included in this study. The effect of the missing values was assessed using rating of last dental visit and factor score of COPAS. Analyses with an item that rated the dental visit also assessed the effects of missing values with 20,971 valid responses. More responses were expected, as concepts such as continuity of care were not necessary for its response. Analysis was also calculated using factor scores of COPAS derived from structural equation modelling that accounted for missingness (full-information maximum likelihood estimation) (n=20,971).

Data analyses

Descriptive statistics were reported with sample weighting while accounting for clustering at the stratum level. The confounding structure comprised of variables related to socioeconomic position, remoteness, oral health status, and states and territories. These variables were included based on the DAG that was conceptualised based on prior publications and expert judgement. Socioeconomic position was assessed using income, education, equivalised income (ABS 2016) and parent's country of birth. This was based on a directed acyclic graph that examined the relationship for applying the appropriate analyses.

Oral health rating was another variable that was adjusted for in the models, and it was measured on a five-point rating scale that ranged from excellent to poor. The analyses were carried out after stratifying the sample into Indigenous and non-Indigenous children. Mixed effects models (using Stata command `meglm`) were used for the assessment of the effect of the choice of private or public care facility on COPAS and its nine dimensions. Models were checked for interactions and exponential variables. Then on the overall sample (without stratification), effect modification was evaluated for the extent of change in the main effect of public versus private care on COPAS and its dimensions due to Indigenous status.

Currently accepted methods were used for the calculation of effect modification on continuous and dichotomous value for COPAS (VanderWeele and Knol 2014), while adjusting for all the confounding variables used in the stratified models. A multiplicative term was entered in the regression model with the continuous outcome to assess the additive effects. Whereas a log-linear model was used, and the coefficient was exponentiated for assessing the multiplicative effects.

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4 Critical review

Critical review of the validity of patient satisfaction questionnaires
pertaining to oral healthcare

Status: published

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Name of Principal Author (Candidate)	Nair, R		
Contribution to the Paper	Developed the methodology, collected data, reviewed the papers, prepared the primary draft and critically reviewed the draft.		
Overall percentage (%)	85%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	27-Nov-2018

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

- i. the candidate's stated contribution to the publication is accurate (as detailed above);
- ii. permission is granted for the candidate to include the publication in the thesis; and
- iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Ishaque, S		
Contribution to the Paper	Reviewed the methodology, reviewed the papers to ascertain consistency, critically reviewed the draft.		
Signature		Date	27-Nov-2018
Name of Co-Author	Spencer, AJ		
Contribution to the Paper	Contributed to the methodology and critically reviewed the draft manuscript.		
Signature		Date	7 Jan 2019
Name of Co-Author	Luzzi, L		
Contribution to the Paper	Supervised the development of the methodology and critically reviewed the draft manuscript.		
Signature		Date	7 Jan 2019
Name of Co-Author	Do, LG		
Contribution to the Paper	Supervised the development of the methodology, contributed to the interpretation of the results, and critically reviewed the draft manuscript.		
Signature		Date	7 Jan 2019

4.1 Linkage to the body of work

This critical review was carried out to gain an overview of the conceptual background for the assessment of the performance of oral care using patient satisfaction surveys, as well as the psychometric properties of previously published patient satisfaction surveys. Patient satisfaction surveys were used here, as these were the important scales that primarily assessed performance of oral care from the perspective of the care-receivers. This paper starts with an overview of the concepts related to measurement of the performance of healthcare. Then it describes patient satisfaction in healthcare and more specifically that related to oral health. It then searched and found 14 instruments for patient satisfaction of oral care and described its domains and assessed their psychometric properties.

4.2 Highlights

1. This paper addressed, for the first time, the conceptual and analytical basis for the patient satisfaction surveys that are available to measure oral healthcare.
2. The review identified that although there were several relevant instruments, the extent of external validity and reliability of these instruments were largely unassessed.
3. Further, the previous instruments also reported on limited psychometric properties and the testing was restricted to adults who were mostly recruited from clinical populations or at times from general populations.

Critical review of the validity of patient satisfaction questionnaires pertaining to oral health care

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Abstract

Objectives: Review the validation process reported for oral healthcare satisfaction scales that intended to measure general oral health care that is not restricted to specific subspecialties or interventions.

Methods: After preliminary searches, PUBMED and EMBASE were searched using a broad search strategy, followed by a snowball strategy using the references of the publications included from database searches. Title and abstract were screened for assessing inclusion, followed by a full-text screening of these publications. English language publications on multi-item questionnaires that report on a scale measuring patient satisfaction for oral health care were included. Publications were excluded when they did not report on any psychometric validation, or the scales were addressing specific treatments or subspecialties in oral health care.

Results: Fourteen instruments were identified from as many publications that report on their initial validation, while five more publications reported on further testing of the validity of these instruments. Number of items (range: 8-42) and dimension reported (range: 2-13) were often dissimilar between the assessed measurement instruments. There was also a lack of methodologies to incorporate patient's subjective perspective. Along with a limited reporting of psychometric properties of instruments, cross-cultural adaptations were limited to translation processes.

Conclusions: The extent of validity and reliability of the included instruments was largely unassessed, and appropriate instruments for populations outside of those belonging to general adult populations were not present.

KEYWORDS

dental services research, outcomes, program evaluation, quality of care

1 | INTRODUCTION

It can be argued that the overall aim of healthcare systems is to sustain and improve the health of individuals under its care.¹⁻³ So the ultimate test of a healthcare system is to assess the extent to which the relevant healthcare system helps the people it intends to help.⁴ Healthcare systems assist people by providing the services that are required by them. As with most activities, services delivery could result in some benefits and harms to the people it aims to help. An earlier report from Institute Of Medicine (IOM) stated that there

were "serious and widespread errors in health care delivery that resulted in frequent avoidable injuries to patients."⁵ Thus, evaluation and feedback of healthcare delivery are essential for healthcare systems to realize their aim.

Donabedian (1988)⁶ suggested a categorization of information that can be used to evaluate the quality of health care. This categorization involved three categories: structure, process, and outcome. As healthcare systems are built to achieve the desired outcomes for people under its care, such outcomes remain important.⁷ Whereas the structure and process enable the realization of these outcomes,

also the structure and process are experienced by the individuals to various extents. This experience of structure and process can be observed when patients interact with the personnel or the physical location of a care delivery centre. Such interactions and other related experiences also contribute to making the quality of the process and structure an important part of the healthcare evaluation.⁶

Patient-centred care has been advocated for healthcare delivery.⁸ It has been conceptualized and discussed in the dental context as well.⁹ As individuals receiving healthcare services are the reason for its relevance, quality of care evaluated from individuals' perspective is an important part of the quality assessment. Patient satisfaction measures represent one aspect in the assessment of the performance of healthcare systems.¹⁰ Ware et al (1983)¹⁰ defined patient satisfaction as the subjective evaluation of healthcare services and personnel. Thus defined, the patient satisfaction forms an important patient reported outcome for the assessment of the quality of health care. This perception of service quality was theorized to arise from the gap between customer expectations and customer experiences.¹¹

There are some inherent issues with the measurement of the quality of services including the intangibility of services (vs goods); heterogeneity due to the variability across customers, service providers and varying perceptions over time; and the inseparability of production and consumption.¹² An earlier systematic review that examined patient satisfaction questionnaires in health care noted that patient satisfaction was conceptualized and operationalized in several ways.¹³ It was also reported that there were considerable variations in the items and dimensions used by instruments that are available. This variability was related to the availability of questionnaire instruments in health care that lacked comparability, and even reported a frequent absence of similar underlying dimensions.

In dentistry, patient satisfaction was gauged as an important measure of quality, warranting the creation of instruments for its measurement.¹⁴ Psychometric testing showed that patient satisfaction was a multidimensional concept.^{15–17} Often the dimensions included in patient satisfaction questionnaires pertained to technical competence, interpersonal factors, convenience, costs and facilities.¹⁴ Due to this multidimensionality, multi-item questionnaires are required for adequately assessing patient satisfaction. The relevant domains for these instruments in oral health were often adapted from pre-existing instruments in overall health care such as the Medical Satisfaction Questionnaire and the Medical Interview Satisfaction Survey.^{16,17} Thus, oral health care with its mostly service-oriented approach had used patient satisfaction surveys with varying conceptual dimensions.^{17–20} Similar conclusions were found in the systematic review of healthcare satisfaction surveys, where there was a lack of a gold standard, and there was heterogeneity.¹³ The theoretical basis and the content areas of the various dental questionnaires also suggest that there is heterogeneity between the dental instruments. Other than the dimensions present in these instruments, there were also important differences in the conceptualization of patient satisfaction for questionnaire construction, where some of

the instruments measured the overall healthcare perspective, whereas others measured satisfaction for a specific visit.²¹

When confronted with heterogeneity in theoretical basis and in content, it is important to evaluate their psychometric validation to assess the extent to which these instruments were measuring what they were intended to measure. A current literature search shows an absence of reviews that have assessed oral healthcare satisfaction scales for their validity and reliability. Hence, this critical review aims to critically review the validation process of the oral healthcare satisfaction scales measuring general oral health care.

2 | MATERIALS AND METHODS

To critically review the validity of multi-item questionnaire instruments that assess patient satisfaction related to oral health care; patient satisfaction was defined, inclusion-exclusion criteria were developed, relevant searches were carried out, articles were screened, relevant references were searched, and the finally included articles were critically evaluated. In this study, patient satisfaction definition used earlier by Ware et al (1983)¹⁰ was operationalized. Thus, the included instruments were the ones that assessed the healthcare services and personnel from a subjective care-recipient or their care-givers' (such as parent or guardian) perspective.

2.1 | Inclusion/exclusion criteria

Publications in the English language were included when they detailed multi-item patient satisfaction questionnaire of general oral health care, as reported by patients or the population serviced by the appropriate healthcare system. Included instruments measured as a scale or index with at least a simple additive score reflecting the patient satisfaction with general oral health care. Questionnaires that used a single item or a global question for the measurement of patient satisfaction were excluded. Instruments with no psychometric validation were also excluded. Similarly, questionnaire instruments that aim to measure satisfaction of specific treatments were excluded.

2.2 | Search strategy

Based on the aim and the inclusion/exclusion criteria, preliminary searches were carried out to scope for relevant search terms. It was then decided to include terms related to patient satisfaction, dentistry and questionnaires. With this strategy, search terms were built with the help of the research librarian for both PUBMED and EMBASE. For PUBMED, the search was conducted using the following search: (((Patient satisfaction[MeSH] OR Patient satisfaction[TIAB])) AND ("Dentistry"[Mesh] OR "dentistry"[TW] OR "dental"[TW] OR "oral health"[TW])) AND ("Dental Health Surveys"[Mesh] OR survey[TW] OR surveys[TW] OR questionnaire[TW] OR questionnaires[TW])). In EMBASE, a search with a similar strategy

with the following terms was used: ("patient satisfaction"/exp OR "patient satisfaction":ab,ti) AND ([article]/lim OR [article in press]/lim OR [review]/lim OR [short survey]/lim) AND (((dent* OR "oral health") NEAR/5 (survey* OR questionnaire*)):ab,ti).

The search results were extracted and imported into Endnote X 7.5©, and duplicates were removed. All the identified publications were assessed for inclusion by screening title and abstract (RN). The publications that matched the inclusion or exclusion criteria or were uncertain based on the title and abstract were separated. A subset of 40 articles were extracted and a second reviewer (SI) reviewed them to check for the implementation of the inclusion-exclusion criteria. All disagreements were discussed and resolved. Full text of this set of articles were then downloaded and further assessed for inclusion.

2.3 | Data extraction and assessment of validation

Data relevant to the validation of the patient satisfaction surveys were extracted but were limited to the most common information that was available in the included publications. Where possible, the following data were extracted: dimensions in the instrument, sample and setting, source of items, number of items, pretesting procedures, item selection criteria, internal consistency and structural validity.

The assessment of validation was carried out using the general guidelines that were published for assessment of the measurement properties of instruments (COSMIN).²² Here, the aspects of the primary validation studies that are of interest include internal consistency, test-retest reliability, measurement error, content validity, structural validity, hypothesis testing, responsiveness, interpretability and generalizability. For the instruments that were carried out after the primary validation and applied in dissimilar scenarios, cross-cultural validation and the necessary adaptation were considered more relevant than other aspects of validation.

3 | RESULTS

The PUBMED search was conducted on 7 June 2016, and 1606 publications were obtained. The EMBASE search was conducted on the 24 May 2016, and 273 results were obtained. Thus, the search identified 1879 publications. The publication selection from the initial search to final inclusion is illustrated in Figure 1. After removing duplicates, 1650 publications remained. Based on the screening of inclusion-exclusion criteria, full text of 73 publications was extracted. These included publications, where there was an uncertainty of inclusion from screening the title and abstract. References were searched among the included publications with the same criteria as before. Finally, 19 publications were included in the review, as they reported some extent of psychometric evaluation of patient satisfaction instruments for general oral care.

The 19 included studies were published between 1984 and 2009.^{15-17,23-38} Of these, 14 publications reported initial development and validation (Table 1), whereas the other five publications

were follow-up studies that re-assessed some aspects of validity and reliability (Table 2). The initial validation for most studies ($n = 8$) was conducted among adults attending dental clinics, whereas the rest ($n = 6$) were carried out among adult populations selected from non-clinical settings. Of the primary studies, eight were conducted in the United States, two in Australia, and one each were carried out in India, Japan, Sri Lanka and Sweden. Among the published instruments, Dental Satisfaction Questionnaire (DSQ) and Dental Visit Satisfaction Survey (DVSS) were further assessed for aspects of their validity and reliability in the follow-up studies. Among these, one study used an adaptation of DSQ for assessing the satisfaction of dental care for children from the perspective of their parents.³⁶ All the other follow-up studies were measuring the dental satisfaction among adults. Participants for only one of the studies were selected from dental clinics, and the rest were recruited from nonclinical settings.

3.1 | Primary validation studies

All but three studies^{23,29,31} created items either based on previous instruments used in medicine or were created de novo based on

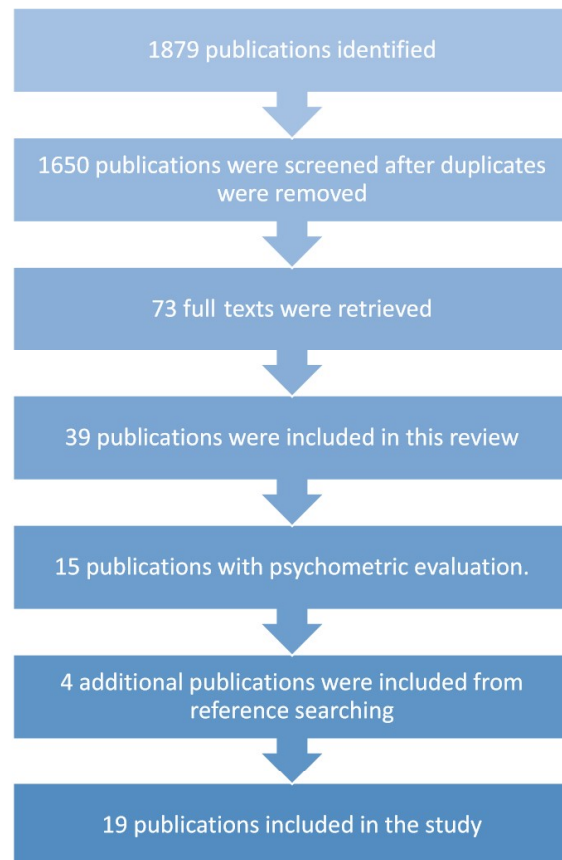


FIGURE 1 Flow of studies through the inclusion process [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Development and testing of dental patient satisfaction instruments, as reported in their initial publications

Authors, Year	Sample included	Theoretical basis	Number of items	Pretesting (n); procedures	Item selection (n)	Internal consistency	Structural validity (n)
Koslowsky et al 1974 ²⁷	Patients—dental clinic USA	De novo	20	Yes (89); alternate form reliability	Expert judgement	Alpha (428) ($\alpha=0.89$)	None
Murray and Weise. 1975 ²⁶	Patients—dental clinic USA	De novo	15	Yes (24) split-half reliability	Expert judgement		EFA (40)
Hengst and Roghmann, 1978 ²⁴	Mothers on welfare USA	De Novo	12	Yes (200); split-half reliability (Rho=0.68)	Expert Judgement		Model fit and EFA (240)
Davies and Ware, 1981 ¹⁷	General population USA	PSQ	19	None	Expert judgement	Alpha (0.81)	EFA (3209)
Corah et al 1984 ¹⁶	Patients—dental clinics USA	MISS	10	None	Expert judgement	Alpha (0.92)	EFA (105)
Chapko et al 1985 ¹⁵	Patients—dental clinics USA	DSQ, Hengst and Roghmann, and De novo	42	None	Expert judgement	Alpha	EFA (7202)
Stewart and Spencer. 1995 ³²	General population—Australian adults Australia	PSQ III, DSQ, MSMC	24	None	Expert Judgement	Alpha (0.88)/retest reliability	EFA (1903)
Stewart and Spencer. 1996 ³¹	General population—Australian adults Australia	PSQ III, DSQ, MSMC	31	None	Expert Judgement	Alpha (0.89)	EFA (576)
Reifel et al 1997 ³³	Patients—Indian Health Service USA	De novo	11	None	Expert judgement	Alpha (0.88-0.93)	None
Chaffin et al 2007 ³⁰	Patients—US Military USA	De novo	11	None	Expert judgement	Alpha (0.95)	EFA (309261)
Stahlnacke 2007 ²⁵	General population—50-y-olds Sweden	Denovo	8	None	NA	Alpha (0.81, 0.54)	EFA (5363)
Imanaka et al 2007 ²³	Patients—Dental School clinic Japan	De novo	23	None	Expert judgement	Alpha (0.95, 0.92, 0.86, 0.89)	CFA (3394)
Shrestha et al 2008 ²⁸	Clinic patients India	De novo	9	None	Expert judgement	Alpha (0.75)	None
Perera and Usgodaarachchi. 2009 ²⁹	General population Sri Lanka	De novo	22	Focus group (30)	Face validation (30)/Delphi (4)	Alpha (0.91)	EFA (117)

expert judgement. Perera and Usgodaarachchi (2009) used three focus groups with 30 participants for item adaptation and creation after extracting relevant items from literature; followed by face validation among 30 participants and a consensus building among four experts using Delphi method.²⁹ Open-ended questions were used by Imanaka et al^{23,31} and the comments section was used by Stewart and Spencer.

All but two studies^{24,26} reported internal consistency for either the full scale, the subscales or both (Table 1). Only one study specified using a statistic other than Cronbach's alpha to report the alpha coefficient and that publication reported using Kuder-Richardson

Formula 20 (KR-20).²⁷ Among the studies that reported internal consistency, seven of them reported the alpha coefficient for the full scale. The alpha coefficient among these studies varied between 0.75 and 0.95. As for reliability, only one publication reported retest reliability,³² using a percentage of agreement between two administrations of the instrument over a 2-week interval.

All but three studies^{27,28,33} reported testing structural validity using an exploratory factor analysis, and one study reporting confirmatory factor analysis. These 12 studies reported the dimensions arising from exploratory or confirmatory factor analysis (Table 3). The number of dimensions reported in these studies ranged from 2-

TABLE 2 Psychometrics from follow-up studies testing of the validity of dental patient satisfaction instruments

Authors, Year	Sample included	Instrument used	Internal consistency	Structural validity (n)
Stouthard et al 1992 ³⁷	Students—freshmen	DVSS	Alpha (0.89)	EFA (487)
Golletz et al 1995 ³⁸	Female guardians	DSQ	Alpha (0.77)	EFA (895)
Hakeberg et al 2000 ³⁴	Four dental clinics	DVSS	Alpha (0.86)	CFA (204)
Brennan et al 2001 ³⁶	Parents and school children	DSQ	Alpha (0.78)	Model fit (2792)
Skaret et al 2004 ³⁵	23-year-olds	DSQ	Alpha (0.81)	EFA (666)

DVSS, Dental Visit Satisfaction Scale; DSQ, Dental Satisfaction Questionnaire.

TABLE 3 Instruments used for measuring dental patient satisfaction and the included dimensions

Authors, Year	Dimensions
Koslowsky et al 1974 ²⁷	Personality, technical ability, office and financial
Murray and Weise. 1975 ²⁶	Economic, convenience and quality
Hengst and Roghmann, 1978 ²⁴	Latent hostility and general glorification
Davies and Ware, 1981 ¹⁷	Access, availability, pain, cost, quality and unhypothesized
Corah et al 1984 ¹⁶	Information communication, understanding-acceptance, technical competence.
Chapko et al 1985 ¹⁵	Dentist-patient relations, technical quality of care, access, patient waiting time, cost, facilities, availability, continuity, pain, auxiliaries perform expanded duties, staff-patient relations, staff technical quality and office atmosphere. 13 dimensions.
Reifel et al 1997 ³³	Access, Communication and Quality
Stewart and Spencer. 1995 ³²	Communication, services received and their results, staff and waiting time, clinic location and appointments, and conceptually unrelated items.
Stewart and Spencer. 1996 ³¹	Communication, services received and their results, staff and waiting time, clinic location and appointments, Dental professional, affordability and conceptually unrelated items.
Chaffin et al 2007 ³⁰	Belief about care and environment.
Imanaka et al 2007 ²³	Treatment, communication, facility and appearance.
Perera and Usgodaarachchi. 2009 ²⁹	Clinical environment, treatment process, outcome of care and cost of care

Stalacke (2007)²⁵ and Shrestha et al (2008)²⁸ did not report the dimensions included in the instruments.

13, with a majority of the studies reporting 2-5 dimensions ($n = 9$). There were several common concepts among the dimensions and items within those dimensions. These pertained to concepts related to the dental office, dental personnel, treatment and treatment-related cost. The concepts related to the dental clinic included access and comfort. The concepts related to dental personnel mainly pertained to communication and other interpersonal interactions. Treatment-related items generally pertained to the quality of care and comfort during treatment. Finally, the cost was a part of all instruments that were made for populations that largely relied on private funding. Two exceptions to this were those reported by Hengst and Roghmann (1978), and Stewart and Spencer (1995),^{24,32} although the latter included the cost in a follow-up version of the instrument.³¹ Although there were conceptual similarities, there were significant differences in the contents of items between the included instruments.

Other than structural validity, Corah et al (1984)¹⁶ assessed construct validity using hypothesis testing. However, there was no mention of the magnitude or direction of expected change due to the intervention that was tested in the hypothesis testing. None of the

other studies reported using hypothesis testing for assessing construct validity.

3.2 | Follow-up studies

Three of the five follow-up studies were carried out in languages other than English (Table 2).^{34,35,37} These three languages were Dutch, Swedish and Norwegian and were carried out in Netherland, Sweden and Norway, respectively. Among the translated versions, Southard et al (1992)³⁷ used a single literal translation from English to Dutch. Whereas, Hakeberg et al (2000)³⁴ reported the use of four independent translators, with two of them translating from English to Swedish and two independent translators translating back from Swedish to English. In the Norwegian version of the DSQ, Skaret et al (2004)³⁵ reported three investigators translating from English to Norwegian and an independent translator carried out the back-translation. None of the publications reported measures for settling conflicts in translations or forming committees for decision-making.

Among the measures that were not reported by any of the studies include inter-examiner reliability, measurement error (as reported

using standard error of measurement, smallest detectable change or limits of agreement) and responsiveness.

4 | DISCUSSION

This critical review identified 14 publications that detailed psychometric validation of instruments measuring dental patient satisfaction regarding general oral health care. As patient satisfaction is patients' subjective rating of healthcare services and personnel, incorporating the patients' subjective perspective is important for the validity of the instruments that measure patient satisfaction. Methodological considerations for the inclusion of patients' satisfaction were reported only in three of the 19 included publications.^{23,29,31} There were limited details regarding the details of the focus groups used,²⁹ the criteria used for inclusion of feedback in to the questionnaires,³¹ or the details of the use of open-ended questions that were incorporated in to the questionnaire.²³ Among these, a publication in Japanese language was not assessable due to language barrier. All the other publications reported using items that were either adapted from medical instruments or were developed from an expert perspective.

Besides the lack of incorporation of patient perspectives, there was a general lack of consideration for populations other than adults in the contexts that these instruments were created in. This suggests that the other populations that may have varied experiences with the healthcare systems or other types of healthcare systems may not be accounted for in these instruments. Such populations could include children and adolescents who can either respond directly or through care-giver proxy (parent or guardian).

Apart from the need for patient perspectives and inclusion of various groups, there is also a need for appropriate theoretical basis in the measurement so that the instruments remain valid.²² From this perspective, the included instruments were developed from various theoretical bases. Some of these theoretical bases were as simple as disconfirmation of expectations that did not include a conceptualization of the domains that need to be measured, while others gave guidance on the domains that need to be included. Even in the cases where the domains were given, they were often based on a review of prior instruments that were available. With this heterogeneity in the theoretical basis and a general lack of inclusion of patient perspectives may indicate lower content validity for the patient satisfaction instruments. An exception to this trend was a study that used focus groups and Delphi technique for assessing content validity, where four experts were involved in the consensus building for the content of this instrument.²⁹ But the details of the methods were not provided, and thus the extent of its implementation remains unascertainable.

The deficiencies in content validity can also be seen from the variations between the items and dimensions that are present between the instruments measuring oral health patient satisfaction. There was considerable variability between the instruments regarding the number of dimensions (range: 2-13 dimensions) and the

number of items used (range: 8-42 items). Although such variability existed, there were some common ideas. These common ideas were often missing or treated differently in the included instruments. This was similar to the findings of the systematic review of patient satisfaction instruments in health care overall.¹³ There were also differences in the perspective of the instruments. This is apparent in the case of DSQ and DVSS, where DSQ measures an overall perspective of the healthcare system and DVSS measures the satisfaction with a specific visit.^{16,17} Although there were suggestions that measuring from the perspective of a specific visit might have comparative benefits,^{21,39} this finding cannot be unequivocally extended to dental instruments.

Internal consistency was the most commonly reported measurement property. The results suggest that all the instruments that reported internal consistency for the whole scale were adequate, with the coefficient of alpha ranging between 0.75 and 0.93 (Table 1). This suggests that the items in these instruments can be considered to be parallel measurements with adequate unidimensionality for scale construction.⁴⁰ Although internal consistency was commonly reported, most studies did not report both scale and subscale values. As Davies and Ware (1981)¹⁰ suggested, there may be benefits in assessing the differences in subscales, rather than assessing changes only from the whole scale. The lack of subscale internal consistency values may limit the ability to carry out comparisons of subscales that assess their relationship with variables of interest.

Measures of reliability were not reported for almost all studies. This meant an absence of adequate quantification of the amount of variation between interviewers, where interviewers were used. Similarly, there were no reports of stability of scores over time, except one study that reported the percentage of change in a 2-week period.³² Besides reliability, none of the instruments reported on absolute measurement error or responsiveness. The lack of measurement error indicates that there is an unknown amount of error in the measured values in the instruments and the smallest amount of change that is meaningful is also uncertain. On the other hand, a lack of reported responsiveness of the instrument results in a lack of meaning in a change in score, as this change cannot be translated into a meaningful quantification.

It was suggested that there might be differences in the domains and items related to patient satisfaction in dissimilar populations.¹³ Thus, there may be a need for adequate cross-cultural adaptations of patient satisfaction instruments. The commonly reported adaptations were limited to translation procedures. None of the publications reported re-evaluations of content validity of the instruments. Such procedures for cross-cultural adaptations are recommended for patient reported measures, of which patient satisfaction is one.

The results of this critical review suggest that only a few of the recommendations put forth by the consensus criteria in COSMIN²² were implemented by the individual studies, and the follow-up studies did not improve this further. Thus, the extent of validity and reliability of the included instruments is largely unassessed and consequently unknown. There was also uncertainty regarding the validity of these instruments among populations outside of general

adult population and the settings where these instruments were created and tested.

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5 Empirical study 1

Psychometric properties of the Child Oral-care Performance Assessment Scale (COPAS).

Status: Made corrections according to first round of reviewer comments (major revision) and submitted the revised manuscript to Community Dentistry and Oral Epidemiology on 30th of December 2018. The revised version is presented in this Thesis.

Statement of Authorship

Title of Paper	Psychometric properties of the Child Oral-care Performance Assessment Scale (COPAS).
Publication Status	<input type="checkbox"/> Published <input type="checkbox"/> Accepted for Publication <input checked="" type="checkbox"/> Submitted for Publication <input type="checkbox"/> Unpublished and Unsubmitted work written in manuscript style
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Name of Principal Author (Candidate)	Nair, R		
Contribution to the Paper	Developed the methodology, conceptualised the analyses, carried out the analyses, prepared the primary draft and critically reviewed the draft.		
Overall percentage (%)	50%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature	_____	Date	27-Nov-2018

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

- i. the candidate's stated contribution to the publication is accurate (as detailed above);
- ii. permission is granted for the candidate to include the publication in the thesis; and
- iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Do, LG		
Contribution to the Paper	Supervised the development of the methodology, contributed to the preparation of the manuscript, contributed to the interpretation of the results, and critically reviewed the draft manuscript.		
Signature	_____	Date	7 Jan 2019
Name of Co-Author	Spencer, AJ		
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Contribution to the Paper	Supervised the development of the methodology, contributed to the interpretation of the results, and critically reviewed the draft manuscript.		
Signature	_____	Date	7 Jan 2019
Name of Co-Author	Roberts-Thomson, KF.		
Contribution to the Paper	Supervised the development of the methodology and critically reviewed the draft manuscript.		
Signature	_____	Date	7 Jan 2019

5.1 Linkage to the body of work

This manuscript reported the psychometric properties of Child Oral-care Performance Assessment Scale (COPAS). The items for COPAS were developed by Do LG and Spencer AJ based on the health performance framework and implemented in National Child Oral Health Study. This manuscript added value to the scale by analysing and reporting its psychometric properties. Two scales were prepared, COPAS (37 items) and COPAS-Partial (31 items), the latter excluded questions that mostly assessed continuity of care, as this may not be relevant in all situations. The study assessed internal consistency, convergent validity with rating of oral care, as well as reliability by splitting the sample while assessing the structural validity for the overall sample and assessed variability in factor structure across the split samples. Thus, this paper utilized the conceptual and practical knowledge in the critical review and implemented a basic set of metrics that could help implement the scale for analysing the performance of oral care in later parts of this thesis.

5.2 Highlights

1. This study assessed the psychometric properties of domains and overall scale and found that there was acceptable internal consistency, convergent validity, and structural validity of COPAS and COPAS -Partial.
2. Both scales in this form were found to be suitable for further testing and application to measure the performance of oral care among children.

Title: Psychometric properties of the Child Oral-care Performance Assessment Scale (COPAS).

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Abstract:

Aim: This study aimed to assess the psychometric properties of Child Oral care Performance Assessment Scale (COPAS).

Methods: Items for the instrument were developed, and pilot tested. This questionnaire was implemented in a national survey (National Child Oral Health Survey 2012-14), whose aims included the assessment of the performance of oral care. This nationally representative sample of 23,538 respondents with complete data was divided into five groups: a main validation group and four cross-validation groups, using blocked randomization. Two scales were constructed, full scale with 37 items (COPAS) and a partial scale with a sub-set of 31 items (COPAS-Partial). Internal consistency was assessed using Cronbach's alpha. Construct validity was assessed using correlation coefficients, and structural validity was ascertained in the main validation group and confirmed in the cross-validation groups using structural equation models.

Results: Cronbach's alpha for COPAS was 0.95, and for COPAS-Partial was 0.94. The convergent validity of global satisfaction with oral care and the sub-scales was $\rho=0.29$ to 0.51 , and that with the overall scales was $\rho=0.59$ for COPAS and $\rho=0.59$ for COPAS-partial. COPAS (Root mean squared error of approximation(RMSEA) = 0.06, Comparative fit index(CFI) = 0.90, Tucker-Lewis index(TLI) = 0.89, and Coefficient of determination(COD) = 0.99) and COPAS-Partial (RMSEA= 0.07, CFI= 0.91, TLI= 0.90, COD= 0.97) had adequate fit. Structural invariance was present (p-value= 0.97).

Conclusion: There was acceptable structural validity, construct validity and internal consistency in the models tested for COPAS and COPAS-Partial. COPAS has potential use in the evaluation of the delivery of dental services to children.

Introduction:

Dental diseases command attention owing to their high prevalence among individuals across various age groups and countries.¹ These diseases, in turn, require care provision to alleviate their impacts on the quality of life. The high prevalence¹ along with the high cost of care provision²⁻⁴ necessitates appropriate evaluation of healthcare strategies that maximize the desirable outcomes for the overall available resources.

It can be argued that the overall aim of healthcare services is to provide beneficial outcomes to individuals under their care.⁵ In keeping with this perspective, quality of care was defined as “the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge”.⁶ Thus, evaluation of healthcare services requires outcomes that are measured from the patients’ perspective. Such measures are essential for meaningful evaluation of care services. There are several common outcomes such as oral health related quality of life’ and willingness to pay that are available and appropriate for measurement of the outcomes for specific interventions or programs.^{7, 8} Healthcare satisfaction surveys can measure outcomes more broadly,^{9, 10} where they can include all aspects of healthcare provision including structures, processes, and outcomes.^{11, 12} Thus they aim to measure the overall performance of care provision. From the perspective of healthcare evaluation, healthcare satisfaction surveys are defined as a patients’ subjective assessment of the performance of services and personnel that deliver the relevant care.⁹ As the evaluation of healthcare systems can occur either at the level of individuals or for the overall healthcare systems, appropriate measures may enable the quantification of the distribution and the quality of care provision in a healthcare system.

A current critical review¹³ identified several instruments that measure dental satisfaction for overall oral care provision rather than those for specific treatments or subgroups within the overall oral care provision.^{12, 14-26} These questionnaire instruments measure the performance of care using multi-item questionnaires, as the multidimensionality of the concept of oral care satisfaction requires. Between the various instruments, these dimensions were varied in number and concept. This reflects a general lack of consensus on the required dimensions for evaluation of oral care satisfaction, which is similar to that found in overall healthcare.¹⁰ Such uncertainty related to the required dimensionality arises from the limited theoretical framework that dictates the required dimensions for item development. Such theoretical framework was conceptualized in the National Health Performance Framework for assessment of the performance of Australia's healthcare system and it consisted of nine dimensions.²⁷ Similar dimensions were used in other regions as well.²⁸ Theoretical frameworks enable the elucidation of patient satisfaction with adequate dimensionality to measure the overall quality of oral care provision. Though such frameworks are available for the overall assessment of healthcare performance, this has not been used for the measurement of healthcare satisfaction. The multidimensionality and the latent nature of healthcare satisfaction require testing of psychometric properties to understand the measurement properties and dimensionality of such an instrument.^{12, 14-26} Previous studies reported limited psychometric assessments, and these were often limited to internal consistencies and exploratory factor analyses. These instruments were also created for measuring patient satisfaction among general adult populations, and publications that reported on adaptations for measurement of parental satisfaction of oral care for their children

reported limited methodology for assessing the adequacy of such instruments for a younger population.^{29, 30}

Evaluation of oral care for children in Australia is necessary to understand its effect on oral diseases. This is largely due to considerable variability between the dental healthcare provision systems in the various states and territories that differentially prioritize between school-based dental care, public dental services, and other facilities.³¹ The experience of care provision is widely different for those at differing levels of socio-economic positions depending on the availability of public insurance and holding of private health insurance versus those with no insurance. Currently, New South Wales, Victoria, and Australian Capital Territory operate minimal school dental services. Instead these jurisdictions operate community dental services with varying child population coverage. The other Australian states operate school dental services to varying degrees.³² The availability and amount of co-payment and services available are also different for the various regions. A valid measure of performance of oral care for children is necessary to evaluate the impact of such large variability in dental service provision in the various regions of Australia on service utilization, the quality of the rendered services, and the dental health outcomes.

So, there is a lack of instruments with theoretically appropriate dimensionality, especially for instruments that are conceived for measurements of the performance of oral care for children. Here dimensions refer to the various ideas that combine to form the overall scale, and is identified by the interaction of a set of items and the respondents.³³ Such a gap in the availability of measurement instruments can be bridged by developing and adequately testing the psychometric properties of a multi-dimensional instrument with theoretically appropriate dimensionality. This study aims

to present the psychometric properties of Child Oral care Performance Assessment Scale (COPAS), which is a new scale that was developed based on the dimensions put forth in the National Health Performance Framework.²⁷

Methods

Data for this study were drawn from the National Child Oral Health Study (NCOHS) 2012-2014.³¹ A two-stage stratified random sampling procedure was used to draw a representative sample of Australian children aged from 5 to 14 years. This sample included children from all Australian states and territories, and the recruitment of children was carried out from primary and secondary schools.

To draw a representative sample of children from the target population a two-stage stratified sample design was implemented within each state/territory. In the first stage, a sample of schools was selected from a sampling frame of all schools located within each jurisdiction created from a list provided by each jurisdiction which included all public, Catholic and independent primary and secondary schools.

To achieve a good representation of schools, the sampling frame was first split by region and then by primary vs secondary/combined school and then sorted by a composite index of either school or area socioeconomic status. These were the Index of Community Socio-Economic Advantage (ICSEA)³⁴ or Socioeconomic Index for Areas (SEIFA) score³⁵. Schools were then selected with a probability proportional to size of enrolment.

In the second stage a cluster of children was randomly sampled from each participating school. Children were oversampled to accommodate non-response or refusal to participate. Invitations to parents for their child to participate were distributed through schools. Activities were undertaken to encourage participation. Only children whose parents provided signed, informed consent for their child to

participate were included in the study. Questionnaires containing COPAS and other variables were provided to the parents, who then self-completed them. Further details about the study protocol can be found in an earlier publication.³¹

Item Development

The items of the COPAS were developed *de novo* by the researchers. The objective of this process was to develop a multi-item instrument to collect parental observation and assessment of dental care received by their child. This process followed the standard practice as below.

The theoretical framework adopted in developing the dental system performance items was based on the Health System Performance domains from the National Health Performance Framework.²⁷ These domains are Effective, Appropriate, Efficient, Responsive, Accessible, Safe, Continuous, Capable and Sustainable. These nine domains cover most important aspects of a dental care system.

The researchers first developed a list of potential items under each domain by consensus. Wording of each item was refined through discussion and consultation with external researchers. A small convenient group of laypersons who had had a recent dental visit was invited to test the items. A research assistant conducted further interviews with those laypersons. Further discussion reduced the number of items per domains to a minimum of four.

All 38 items and a global rating of dental visit were included in a parental questionnaire completed by 108 school children in Qld. Those children also underwent a dental examination. A preliminary analysis of psychometric properties of the questionnaire was conducted using data of those children. Internal consistency and convergent validity of the questionnaire were acceptable. Therefore, the questionnaire had been accepted for use in the NCOHS.

Data analyses

Data were checked and cleaned to ensure acceptable accuracy. The responses to the 38 items of COPAS were in the form of a bipolar rating scale that ranged from strongly disagree through neutral to strongly agree, with a summative Likert scale of the relevant items (Appendix 1). Items 13, 17, 19 and 20 of COPAS were reverse coded, owing to their negative wording. Item 22 and 27 asked about the child feeling at ease in a clinical situation. So, for parsimony, ease of interpretation of the domains and better model-fit, item 22 was removed from the two scales. Six items contained “Not Applicable” (NA) as an option. These were mostly items that pertained to the continuity of care. Two scales were conceptualized; COPAS that contained 37 items and COPAS-partial that contains items other than those with NA as the option with a total of 31 items. Distribution of item responses was checked for all items, the proposed domains, and the scale totals. To check the stability of the model, cross-validation of the model in a randomly split sample was performed.³⁶ Data were then split into five validation groups for cross-validation of the factor structure. The split was accomplished with a blocked random selection, with a block size of five, resulting in five equal sized groups.

Data were analysed using SPSS 24 and STATA 14. Internal consistency was assessed using Cronbach’s alpha. These were calculated for the relevant domains and the overall scales. Convergent validity was assessed by analyzing the correlation between domains and the overall scales with a global question that measured satisfaction with overall oral care. This correlation was quantified using Pearson’s correlation coefficients. A priori assumption was that there would be mild to moderate correlations, as the single question lacks the adequate dimensionality that a multi-item questionnaire can achieve. Structural validity was assessed using

Structural Equation Modelling (SEM), which uses confirmatory factor analysis as its measurement model.³⁷ Structural validity assessed the nine dimensions in COPAS (Effective, Appropriate, Sustainable, Efficient, Accessible, Responsive, Safe, Capable, Continuous) and COPAS-Partial (eight dimensions) that should reflect the nine dimensions from the theoretical model for COPAS and 8 dimensions for COPAS-Partial (All the dimensions excluding Continuous). These dimensions were the ones outlined in National Health performance Framework.²⁷

A model was built on the main validation group (one among five that were made for cross-validation). The full-information maximum likelihood estimation that accounted for missing values was used. Convergence of the models was sought, the fit was assessed, and parsimonious models were sought. Model fit was assessed using root mean squared error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis index (TLI), and coefficient of determination (COD). RMSEA less than 0.08, CFI and TLI less than 0.9 and COD greater than 0.95 were ascertained as having adequate fit, though these were not considered inviolable limits.³⁷ After the model-fit and parameters were ascertained, cross-validation was sought by assessing structural invariance across the five validation groups.³⁸ Here, structural invariance refers to a lack of significant differences in the factor loading among the models created in the five validation groups. Alpha was set at 0.05.

Results

This study includes valid responses from 23,583 of 24,664 participants who took part in NCOHS. These participants were sampled from 841 primary and secondary schools across Australia. There was almost an equal proportion of girls and boys, with girls forming 50.1% of the group. The median age of the participating children was nine years (mean(SD)= 9.28(2.79)). About a third of the parents of the

participating children were born outside of Australia. Indigenous Australians made up 3.9% of the sample.

Table 1 enumerates the descriptive statistics for the domains and the scales. All the domains and the scales had average values higher than the mid-point for their respective range, and the domains show variability, as expressed by their standard deviations. Internal consistency, as measured by Cronbach's alpha shows that all domains for both COPAS and COPAS-partial ranged between 0.68 for Responsive to 0.96 for Capable-partial (Table 1).

Table 1: Descriptive statistics, internal consistency (Cronbach's Alpha), and convergent validity with global satisfaction for the dimensions and the scales in the overall study sample.

Domain/Scale	Mean (SD)	Minimum	Maximum	Cronbach's Alpha	Global Satisfaction (Pearson's Rho)
Effective	14.8 (3.8)	4	20	0.86	0.35
Effective - Partial	10.8 (2.9)	3	15	0.80	0.29
Appropriate	16.8 (3.2)	4	20	0.86	0.44
Sustainable	17.9 (3.0)	4	20	0.94	0.40
Efficient	16.9 (2.9)	4	20	0.81	0.48
Accessible	24.2 (4.3)	6	30	0.89	0.34
Responsive	12.9 (2.3)	3	15	0.68	0.50
Safe	17.6 (2.7)	4	20	0.88	0.46
Capable	17.1 (3.0)	4	20	0.90	0.51
Capable - Partial	13.3 (2.2)	3	15	0.96	0.50
Continuous	14.6 (4.4)	4	20	0.80	0.39
COPAS	146.8 (24.0)	37	185	0.95	0.59
COPAS-Partial	130.8 (17.8)	35	155	0.94	0.59

For the scale, COPAS had a Cronbach's alpha of 0.95 and COPAS-partial reported 0.94. The convergent validity of the domains and the scales (COPAS and COPAS-Partial) with the global rating for satisfaction with oral care show moderate correlation coefficients ranging from $\rho=0.29$ for Effective-Partial to $\rho=0.51$ for Capable. Similarly, COPAS reported $\rho=0.59$ and COPAS-Partial reported $\rho=0.59$. There was no significant floor or ceiling effect, as there were only 3 participants who reported the lowest possible score, and 286 participants who reported the maximum possible score. Confirmatory factor analysis(CFA) for COPAS was fitted, as hypothesized, with COPAS leading to nine domains that in turn included 37 items (Figure 1). The model also shows that there were covariances (or salient factor loadings), as quantified by the analogous standardized regression coefficients (β), for all the domains on the respective items. In the SEM model, this was true after adjusting for the rest of the components in the SEM. Similarly, the dimensions had covariances with the latent construct of COPAS, indicating a higher-order factorial structure. There was adequate fit with RMSEA of 0.07, CFI of 0.91, TLI of 0.90, a COD of 0.97. Test for structural invariance among the five validation groups is presented in Table 2 with all the p-values being greater than 0.05. Similarly, CFA of COPAS-Partial was fitted with the eight domains that arise from it. These domains include 31 items (Figure 2). The model showed covariances for COPAS-Partial on the domains and the domains in-turn on the respective items. The model also had adequate fit with RMSEA of 0.07, CFI of 0.91, TLI of 0.90, and COD of 0.97. Like COPAS, there was no significant structural variance between the five validation groups for the model tested here (Table 2).

Table 2: Test for structural invariance between the five validation groups for COPAS and COPAS-Partial

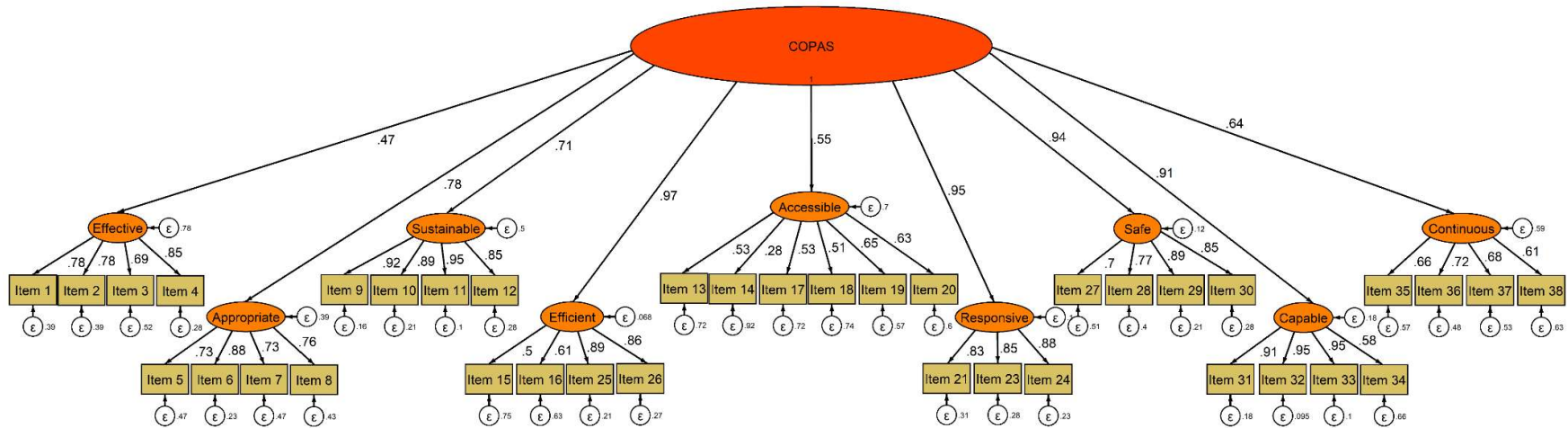
	COPAS	COPAS- Partial
Structural relationship	p>chi2	p>chi2
Effective	0.13	
Effective-Partial		0.10
Appropriate	0.89	0.77
Sustainable	0.39	0.98
Efficient	0.92	0.28
Accessible	0.65	0.50
Responsive	0.12	0.55
Safe	0.24	0.54
Capable	0.34	
Capable-Partial		0.54
Continuous	0.78	

*Statistical significance would indicate that the factor structure is different on at least one of the five validation groups.

Discussion

This manuscript reports on the psychometric properties of COPAS and COPAS-partial. The methodology of this study was designed to estimate the approximation of the dimensional structure of COPAS and COPAS-Partial with the theoretical framework²⁷ that proposed the nine dimensions used in the scales here. By measuring the psychometric properties, this study intended to ascertain the usefulness of these scales for the evaluation of the performance of oral healthcare for children.

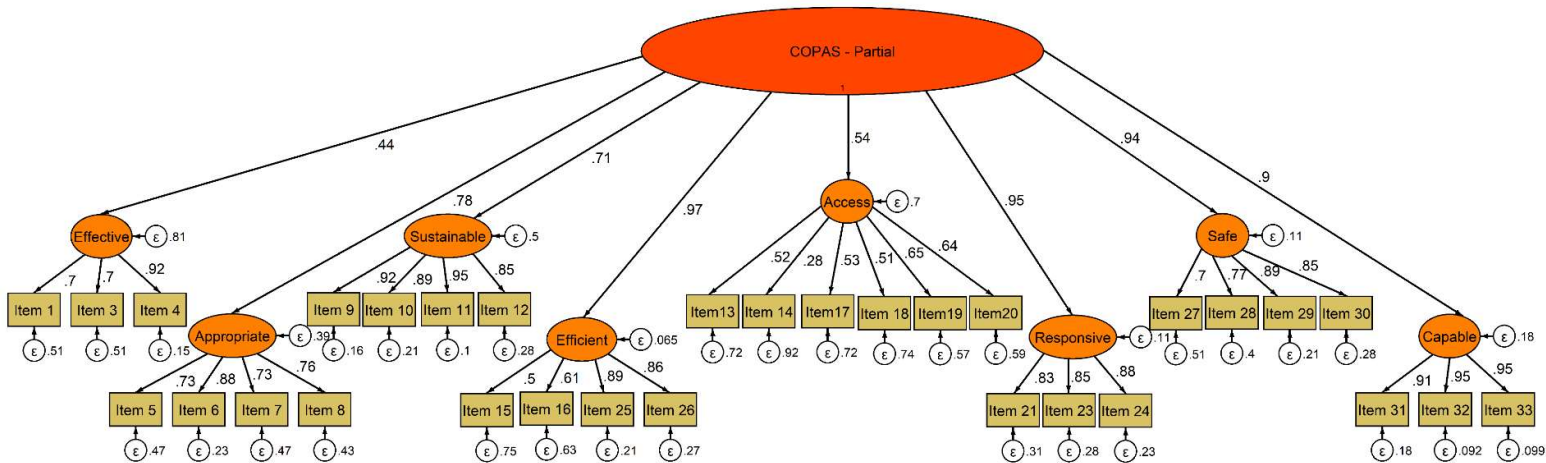
Figure 1: Confirmatory Factor Analysis of Child Oral-care Performance Assessment Scale



*The latent variables are represented in oval shapes, the rectangles are the measured indicators representing the questions in the scale, and the circles are the measurement errors. The numbers next to the lines representing the relationships are the β (Standardized regression coefficients).

*Fit indices reported: Root mean squared error of approximation = 0.06, Comparative fit index = 0.90, Tucker-Lewis index = 0.89, and Coefficient of determination = 0.99

Figure 2: Confirmatory Factor Analysis of Child Oral-care Performance Assessment Scale-Partial



*The latent variables are represented in oval shapes, the rectangles are the measured indicators representing the questions in the scale, and the circles are the measurement errors. The numbers next to the lines representing the relationships are the β (Standardized regression coefficients).

*Fit indices reported: Root mean squared error of approximation = 0.07, Comparative fit index = 0.91, Tucker-Lewis index = 0.90, Coefficient of determination = 0.97

Previously, adaptations of the Dental Satisfaction Questionnaire (DSQ) were used to measure the patient satisfaction among children.^{29, 39} In-turn, 16 items of the DSQ was adapted from 43 items of an instrument that measured of patient satisfaction with medical care.⁴⁰ Three additional items were added that measured pain related concepts. These items measured access, availability/convenience, cost, pain management, quality and an unhypothesized dimension. Both the DSQ and its adaptations that measured patient satisfaction with child oral healthcare were not tested for adequacy of dimensionality and reported limited psychometric testing. COPAS attempted to overcome some of these known issues by creating items using the dimensions proposed by the National Health Performance Committee²⁷, and by assessing further psychometric properties that assess the extent of adherence to this conceptual framework.

Cronbach's alpha for the domains and the overall scales had a moderate to high internal consistency.^{41, 42} The Cronbach's alpha for the overall scales was relatively high, and there was very little difference between the Cronbach's alphas for COPAS and COPAS –partial. These can be expected, as Cronbach's alpha tends to level off in scales that have 19 or more items.⁴¹ But the interpretation of the Cronbach's alpha for sub-scales from the domains suggest a consistently adequate internal consistency in the sub-scales. The standardized regression coefficient between the domains and the overall scales similarly show a consistently high association.

Similarly, convergent validity assessed by the correlations between the domains and scales with the global question for satisfaction with oral healthcare reports moderate correlations with some variations. Such variations can be expected, as it is not feasible to expect that the global question would capture all of the multi-dimensionality of the concept of oral healthcare performance.^{20, 27} This is also the

reason for using multi-item questionnaires for the measurement of patient satisfaction with oral healthcare performance.¹⁰

Confirmatory factor analyses using SEM found structural relationships between the latent variables that were consistent with the theoretical framework²⁷ upon which COPAS was conceptualized. All estimates were statistically significant, though this can be partly due to the large sample-size that was used in the analyses. All the relationships estimated in the SEMs had reasonable magnitude in their standardized regression coefficients, and due to the large sample-size, the magnitude of the standardized regression coefficients is relevant for the interpretation of the relationships. Stability of the model was assessed using a split-sample method for cross-validation.³⁸ Here the sample was split randomly into five mutually exclusive groups, rather than the more customary two groups. The decision to split into five validation groups was based on the availability of a large sample-size and the possibility of more extensively assessing the stability of the scales. The relationship between the overall scales and the domains was tested across the five validation groups. This test found that the structural components were invariant between the five validation groups, with none of the groups reporting statistically significant differences in the structural components.

Six items that contained N/A (Not Applicable) as an option were excluded from the partial scale. The COPAS-Partial was conceptualized to be more suitable for assessment of oral healthcare performance among children who are less likely to have had continuous care. Whereas, COPAS provides a more comprehensive measurement of the oral healthcare performance. The additional items that were used in COPAS are important for measuring continuous care and the effectiveness of care provided. These were a part of the conceptualization of performance of

healthcare,²⁷ and as per face validity and convergent validity seems important and related to the concept of healthcare. Davies and Ware²⁰ suggested that the use of sub-scales would be important for meaningful assessments. Similarly, the sub-scales would also be important for meaningful analyses for specific research questions. For instance, if the research or policy question pertains to access or perceived-effectiveness of treatment, then those sub-scales would be more important than the whole scale.

Various locations in Australia have substantial differences in the availability, co-pay, and types of public funded care.³² These variabilities in the dental care system along with the various levels of access (including the lack thereof) to private and public insurance necessitates the assessment of quality of dental care. COPAS was designed to assess the extent to which these varied care services provide for the needs of the various populations. To this end, there is a need to assess the responsiveness and discriminant validity of COPAS in appropriate causal models to further assess its applicability. The current psychometric testing suggests that COPAS has the potential for evaluation of the performance of different dental healthcare systems for children.

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5.3 Appendix

Table 1: Items in the questionnaire, along with the frequency of the responses.

Item number	Question	Response*	Frequency	Percentage
Item 01	The dental care my child received improved his/her oral health	1	635	3.20%
		2	1125	5.60%
		3	6263	31.10%
		4	5862	29.10%
		5	6229	31.00%
		Total	20114	100.00%
		Missing	3469	
Item 02	The dental treatment my child received fixed his/her oral problems	1	855	6.40%
		2	1079	8.00%
		3	4226	31.40%
		4	3292	24.50%
		5	4009	29.80%
		Total	13461	100.00%
		Missing	3041	
		N/A	7081	
Item 03	My child's oral health would have been worse if he/she had not received the dental treatment	1	2839	13.80%
		2	2661	12.90%
		3	5607	27.30%
		4	3990	19.40%
		5	5473	26.60%
		Total	20570	100.00%
		Missing	3013	
Item 04	The dental care my child received improved his/her oral well-being	1	1022	4.90%
		2	1513	7.30%
		3	6252	30.30%
		4	6325	30.60%
		5	5545	26.80%
		Total	20657	100.00%
		Missing	2926	

Item 05	My child was given advice on oral self-care	1	636	3.00%
		2	857	4.10%
		3	2646	12.70%
		4	6950	33.30%
		5	9775	46.90%
		Total	20864	100.00%
		Missing	2719	
Item 06	The care my child received was appropriate for his/her dental needs	1	336	1.60%
		2	471	2.30%
		3	2170	10.40%
		4	7054	33.80%
		5	10824	51.90%
		Total	20855	100.00%
		Missing	2728	
Item 07	There was a strong emphasis on prevention of future dental problems	1	688	3.30%
		2	1114	5.40%
		3	3721	17.90%
		4	6160	29.70%
		5	9088	43.80%
		Total	20771	100.00%
		Missing	2812	
Item 08	I felt confident that my child received no more treatment than was needed	1	526	2.50%
		2	652	3.10%
		3	2605	12.50%
		4	6129	29.50%
		5	10869	52.30%
		Total	20781	100.00%
		Missing	2802	
Item 09	The clinic was well maintained and tidy	1	268	1.30%
		2	201	1.00%
		3	1427	6.90%
		4	4915	23.60%
		5	14003	67.30%

		Total	20814	100.00%
		Missing	2769	
Item 10	The clinic appeared to have enough staff	1	388	1.90%
		2	468	2.30%
		3	1934	9.30%
		4	5104	24.50%
		5	12902	62.00%
		Total	20796	100.00%
		Missing	2787	
Item 11	The clinic appeared to be well-equipped	1	285	1.40%
		2	247	1.20%
		3	1773	8.50%
		4	5225	25.10%
		5	13263	63.80%
		Total	20793	100.00%
		Missing	2790	
Item 12	The staff at the clinic were friendly and happy	1	331	1.60%
		2	289	1.40%
		3	1480	7.10%
		4	4735	22.70%
		5	13985	67.20%
		Total	20820	100.00%
		Missing	2763	
Item13recoded	My child did not get recommended dental treatment because of the cost	1	957	4.90%
		2	685	3.50%
		3	2011	10.30%
		4	2513	12.90%
		5	13333	68.40%
		Total	19499	100.00%
		Missing	4084	
Item 14		1	3040	15.80%
		2	2429	12.60%

	I felt protected financially against possible expenses for my child's dental care	3	6259	32.40%
		4	3314	17.20%
		5	4253	22.00%
		Total	19295	100.00%
		Missing	4288	
Item 15	The dental care my child received was good value for money	1	701	3.60%
		2	1303	6.60%
		3	4782	24.30%
		4	4922	25.00%
		5	7991	40.60%
		Total	19699	100.00%
		Missing	3884	
Item 16	The dental care my child received was a good investment for his/her future oral health	1	402	2.00%
		2	567	2.90%
		3	3142	15.90%
		4	5698	28.80%
		5	9950	50.40%
		Total	19759	100.00%
		Missing	3824	
Item17recoded	I deferred/delayed making my child's last dental visit because of the cost	1	1750	8.90%
		2	1447	7.40%
		3	2304	11.70%
		4	2596	13.20%
		5	11521	58.70%
		Total	19618	100.00%
		Missing	3956	
Item 18	My child was able to access care when needed	1	889	4.50%
		2	1104	5.60%
		3	3847	19.50%
		4	5650	28.60%
		5	8261	41.80%
		Total	19751	100.00%
		Missing	3832	

Item19recoded	The days/hours the clinic was open prevented my child from getting care when wanted	1	864	4.40%
		2	1108	5.60%
		3	2675	13.60%
		4	3685	18.70%
		5	11371	57.70%
		Total	19703	100.00%
		Missing	3880	
Item20recoded	The distance to the clinic prevented my child from getting care when wanted	1	596	3.00%
		2	639	3.20%
		3	1810	9.20%
		4	2965	15.10%
		5	13684	69.50%
		Total	19694	100.00%
		Missing	3889	
Item 21	Communication between the dental care provider and my child was appropriate for my child	1	246	1.20%
		2	363	1.80%
		3	2156	10.60%
		4	6247	30.60%
		5	11374	55.80%
		Total	20386	100.00%
		Missing	3197	
Item 22	My child was relaxed about attending the clinic for dental care	1	619	3.00%
		2	1145	5.60%
		3	3073	15.00%
		4	6187	30.30%
		5	9420	46.10%
		Total	20444	100.00%
		Missing	3139	
Item 23	I received enough information to make an informed decision on consent for treatment	1	294	1.40%
		2	424	2.10%
		3	2844	14.00%
		4	6403	31.60%
		5	10317	50.90%

		Total	20282	100.00%
		Missing	3301	
Item 24	My child's dental care provider gave useful feedback about my child's oral health	1	354	1.70%
		2	593	2.90%
		3	2173	10.70%
		4	6534	32.10%
		5	10729	52.60%
		Total	20383	100.00%
		Missing	3200	
Item 25	The dental services my child received were efficient	1	215	1.10%
		2	379	1.90%
		3	2286	11.20%
		4	6675	32.80%
		5	10801	53.10%
		Total	20356	100.00%
		Missing	3227	
Item 26	The staff at the clinic worked well together as a team	1	149	0.70%
		2	244	1.20%
		3	2094	10.30%
		4	6022	29.60%
		5	11804	58.10%
		Total	20313	100.00%
		Missing	3270	
Item 27	My child seemed at ease when he/she was with the dental care provider	1	418	2.10%
		2	713	3.50%
		3	2619	12.90%
		4	6418	31.50%
		5	10212	50.10%
		Total	20380	100.00%
		Missing	3203	
Item 28	My child had no bad effects from the dental treatment provided	1	230	1.10%
		2	268	1.30%
		3	1354	6.70%

		4	5502	27.00%
		5	13001	63.90%
		Total	20355	100.00%
		Missing	3228	
Item 29	The staff at the clinic showed consideration for personal well-being (including that of my child and of themselves)	1	167	0.80%
		2	271	1.30%
		3	1909	9.40%
		4	6063	29.80%
		5	11921	58.60%
		Total	20331	100.00%
		Missing	3252	
Item 30	I felt confident that good infection control measures were in place	1	111	0.50%
		2	172	0.80%
		3	1826	9.00%
		4	5960	29.30%
		5	12239	60.30%
		Total	20308	100.00%
		Missing	3275	
Item 31	I had confidence in my child's dental care provider	1	202	1.00%
		2	322	1.60%
		3	1985	9.70%
		4	5947	29.20%
		5	11907	58.50%
		Total	20363	100.00%
		Missing	3220	
Item 32	My child's dental care provider had the skills needed for my child's care	1	152	0.70%
		2	264	1.30%
		3	1894	9.30%
		4	5856	28.80%
		5	12163	59.80%
		Total	20329	100.00%
		Missing	3254	
Item 33		1	132	0.60%

	My child's dental care provider had the knowledge needed for my child's care	2	249	1.20%
		3	1868	9.20%
		4	5834	28.70%
		5	12232	60.20%
		Total	20315	100.00%
		Missing	3268	
Item 34	My child's dental care provider adopted relevant new approaches in caring for oral health	1	304	1.90%
		2	611	3.80%
		3	5006	31.50%
		4	4267	26.80%
		5	5717	35.90%
		Total	15905	100.00%
		Missing	3195	
		N/A	4483	
Item 35	My child was seen by the same dental care provider he/she usually sees	1	2075	12.00%
		2	1505	8.70%
		3	2432	14.10%
		4	2551	14.80%
		5	8689	50.40%
		Total	17252	100.00%
		Missing	3095	
		N/A	3236	
Item 36	My child's dental care provider consulted with or referred my child to other experts/specialists when needed	1	1023	9.60%
		2	696	6.60%
		3	2304	21.70%
		4	2012	19.00%
		5	4570	43.10%
		Total	10605	100.00%
		Missing	3170	
		N/A	9808	
Item 37	My child's dental care provider issued my child a recall notice when a recall visit was needed	1	1960	12.60%
		2	963	6.20%
		3	1940	12.50%

		4	2614	16.80%
		5	8094	52.00%
		Total	15571	100.00%
		Missing	3136	
		N/A	4876	
Item 38	The dental care provider had seen my child's previous dental records (including records from other providers)	1	2146	14.60%
		2	1051	7.10%
		3	2211	15.00%
		4	2407	16.40%
		5	6889	46.90%
		Total	14704	100.00%
		Missing	3224	
		N/A	5655	

*Responses were on a rating scale ranging from Strongly agree (5) to strongly disagree (1).

6 Empirical paper 2

The variations between states and territories in the performance of oral care delivery for children in Australia.

Status: Submitted to Community Dental Health.

Statement of Authorship

Title of Paper	The variations between states and territories in the performance of oral care delivery for children in Australia		
Publication Status	<input type="checkbox"/> Published	<input type="checkbox"/> Accepted for Publication	<input type="checkbox"/> Unpublished and Unsubmitted work written in manuscript style
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Principal Author

Name of Principal Author (Candidate)	Nair, R		
Contribution to the Paper	Developed the methodology, conceptualised the analyses, carried out the analyses, prepared the primary draft and critically reviewed the draft.		
Overall percentage (%)	85%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
Signature		Date	27-Nov-2018

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

- i. the candidate's stated contribution to the publication is accurate (as detailed above);
- ii. permission is granted for the candidate to include the publication in the thesis; and
- iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

Name of Co-Author	Spencer, A		
Contribution to the Paper	Contributed to the methodology and critically reviewed the draft manuscript.		
Signature		Date	7 Jan 2019

Name of Co-Author	Luzzi, L		
Contribution to the Paper	Supervised the development of the methodology and critically reviewed the draft manuscript.		
Signature		Date	7 Jan 2019

Name of Co-Author	Do, LG		
Contribution to the Paper	Supervised the development of the methodology, contributed to the interpretation of the results, and critically reviewed the draft manuscript.		
Signature		Date	7 Jan 2019

6.1 Linkage to the body of work

This manuscript used the psychometrically assessed COPAS instrument from the previous analyses (chapter 5) and quantified the effect of one of the prominent variations in oral care services in Australia, namely the different oral care systems in the different states and territories. The analyses used data from National Child Oral Health Survey 2012-14 that consisted of a representative sample of children from across Australia, with sample weighting that accounted for the representativeness at the level of each state and territory (Do and Spencer 2016). The analyses using mixed effects models, quantified the differences between the various states, with the value of COPAS for each state calculated using predicted marginals. These mixed effects models accounted for clustering at stratum level and applied sampling weights. This study found for the first time, that there were variations in the performance of oral care that was received by children in the various states and territories in Australia. The study also avoided some of the analytical issues in the previous studies by using mixed effects models that did not adjust for effect mediators.

6.2 Highlights.

1. This study found that there were variations in overall ratings for the performance of oral care across Australian states and territories. Tasmania and South Australia had the highest ratings for COPAS.
2. The variations in the performance of oral care among these jurisdictions suggest that the appropriateness of the oral care system with the needs of the population under its care is critical for optimal performance of oral care.

Title page

Title: The variations between states and territories in the performance of oral care delivery for children in Australia.

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Keywords: Program evaluation, Quality of care, Dental services research, Pediatric dentistry, Outcomes

Abstract

Objective: This study aimed to assess the variations in the performance of oral care for children between states and territories in Australia.

Design: This study used data from the National Child Oral Health Survey (NCOHS) 2012- 2014. Mixed-effects models were used to account for the sampling strategy. Where appropriate, parameter estimates, and predicted margins were calculated from the models.

Setting: School going children in Australia.

Subjects: Representative sample of children in the states and territories in Australia.

Outcome measure: A newly developed instrument called COPAS (Child Oral-Care Performance Assessment Scale) measured nine domains of performance of professional oral care provision. COPAS consists of 37 items with a ceiling score of 148 indicating the best performance. A global rating of care was also assessed using a five-point rating scale.

Results: Overall COPAS scores ranged from 112.7 for Queensland to 121.4 for South Australia. Tasmania (119.6) and South Australia (SA) (121.4) had similar COPAS scores, with the other jurisdictions scoring lower. Similar results were found with the global rating of oral care, where children in Tasmania (OR(95%CI)=0.86(0.78,0.94)) rated their child's oral care better than SA (reference category), while the other jurisdictions rated lower. Similarly, Tasmania and SA were rated higher in the nine dimensions of COPAS, with the notable exception being NT scoring higher for the domain effective.

Conclusion: There were variations in overall ratings for the performance of oral care across Australian states/territories. Tasmania and South Australia had the highest rating for COPAS and in most dimensions.

The prevalence of dental diseases is high among Australian children. This prevalence is mostly attributable to dental caries. In Australia, the prevalence of dental caries (52-58%) among 6-year-old children was reported to be more than four times as high as that for asthma (12%), which is another common disease in childhood (AIHW 2009). The disease burden that results from dental diseases impacts the lives of the children and their irreversible nature has the potential to change their oral health for the rest of their lives. The long-lasting repercussions of common dental diseases along with the preventable nature of these diseases demand greater efforts for tackling this societal challenge.

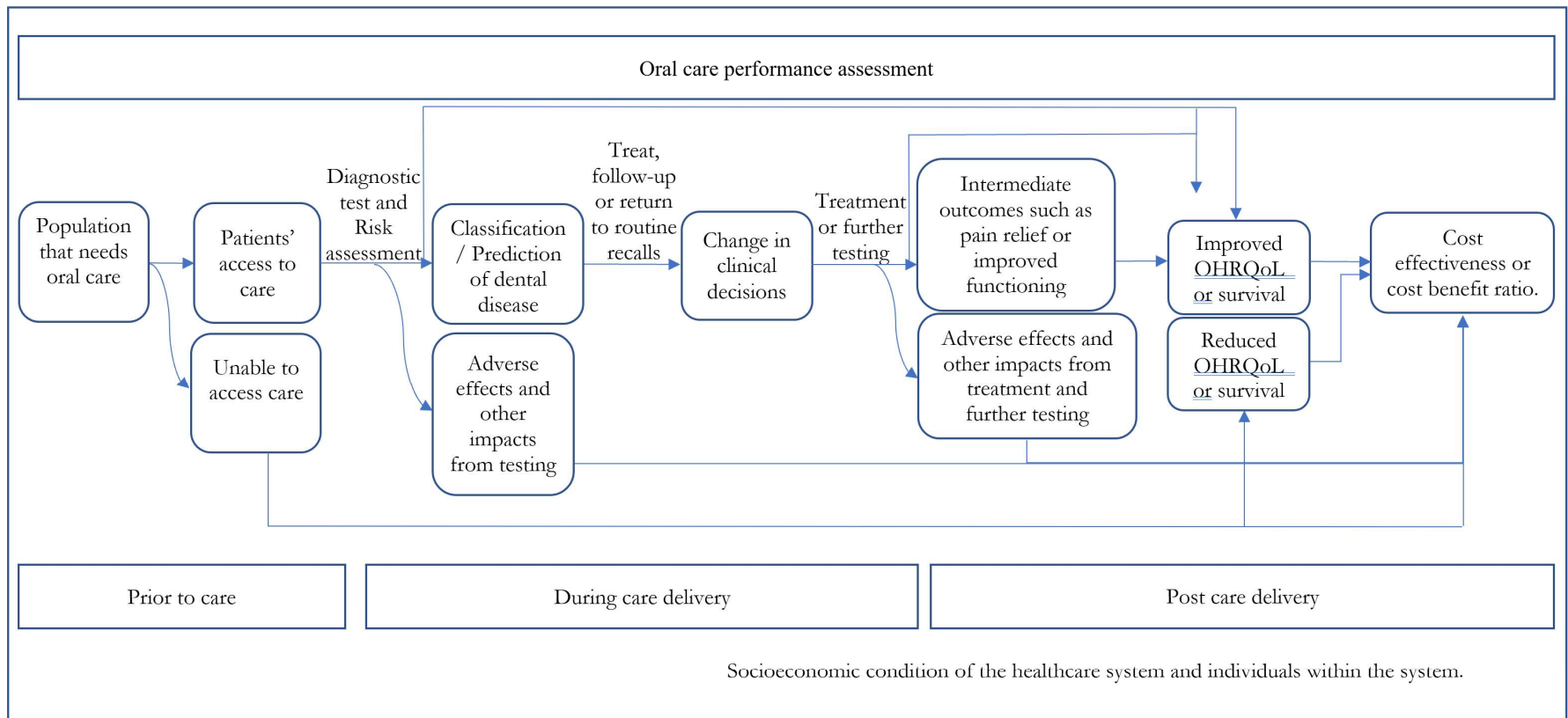
There are several interventions at individual and societal levels that are used to prevent or mitigate the effects of dental diseases among children in Australia (Do and Spencer 2015). These include water fluoridation, the use of fluoridated toothpaste and other professional products, maintenance of dental hygiene, appropriate food intake and visits to dental professionals. Among these, professional care uses a large amount of resources (Australian Institute of Health and Welfare and the Dental Statistics 2013). Professional care can be especially important for children, as interventions such as the use of fluoride varnish and silver diamine fluoride can provide risk reduction among children who may be at high risk for dental caries. With training for effective prevention strategies and appropriate care-provision, care providers can play an important role in reducing the impacts of dental diseases on the children's well-being.

Feedback and evaluation of care provision are essential parts of planning professional oral care provision. Such evaluation is important, as there are reports in healthcare that suggest the occurrence of widespread omission of effective care options, other errors, and injuries that are avoidable (Kohn et al. 2000). When

combined with the possibility of overdiagnosis and provision of inappropriate care, there is a need for evaluation of care (Nair and Ai-Min 2015; Williams 1988). Since the purpose of healthcare is to help care-seekers attain their health-related objectives (WHO 1950), patient-centric care is advocated in healthcare and oral care (Mills et al. 2013). Thus, evaluation from the perspective of care recipients is essential for relevancy of such evaluations of oral care services. Measurement of patient satisfaction with care provision provides an important metric for quantifying the ability of care provision to meet the healthcare needs of the care recipient (Almeida et al. 2015). From this perspective, patient satisfaction was defined as the subjective evaluation of healthcare services and personnel (Davies and Ware 1981). Such a measurement can be visualized using previous models of care delivery (Harris et al. 2001b), with an overarching evaluation of all parts of the care provision that starts from the enabling access to care to maintenance of oral health in a cost-effective manner (Figure 1).

The importance of patient satisfaction for evaluation of healthcare naturally extends to the evaluation of the Australian oral care system. The Australian oral care system for children has several unique features that make it heterogeneous between and within jurisdictions. This owes largely to the varying amount of funding from the state and territories directed towards the oral care of children (NACDH 2012a). Such heterogeneity includes the availability of school dental services (SDS), the provision of care for children through community dental services (CDS), the proportion of children who can access these public dental services, overall funding for the public dental services, co-payments and number of locations for public care facilities (NACDH 2012b). With variation in funding for dental services, there are quantifiable variations in the proportion of children who visit public or private dental services.

Figure 1: Measurement of the performance of oral care system from the perspective of a healthcare provision model.



- The figure describes that the performance of an oral care system spans from the proportion of population that needs care to the overall cost-effectiveness ratios attained by the overall system and parts of it. All the choices in the system are affected to various extents by the socioeconomic condition of the system and the individuals in the system. Here OHRQoL refers to Oral health-related quality of life.

all of Australia) flowing to either public or private services depending on choices made by parents. That choice is influenced by the availability of public dental services (SCARC 1998). It was reported that the availability of public dental care services for children was the highest in Western Australia (WA) and Northern Territory (NT). Queensland (Qld), South Australia (SA), Tasmania (Tas) and Australian Capital Territory (ACT) had intermediate availability, and New South Wales (NSW) and Victoria (Vic) had the lowest (Do and Spencer 2016). The inter-state and territory variations in oral care provision were hypothesized to affect the quality of care provision (NACDH 2012b).

An earlier review found a lack of instruments to measure patient satisfaction that had reported adequate psychometric properties and in turn the instruments had uncertain dimensional adequacy (Nair et al. 2018b). The need for such an instrument that is suitable for the measurement of patient satisfaction among children was present, as none of the current instruments were developed for children and there was limited work carried out to assess their adequacy in this context. A newly developed instrument called COPAS (Child Oral-Care Performance Assessment Scale) was developed using the dimensional structure from the National Health Performance Framework and it reports the performance of oral care system for children from the perspective of parents. The psychometric properties of COPAS suggest that the conceptualized dimensionality was present in the instrument, and it had adequate psychometric properties for its use among children.

With substantial differences between the states and territories in the provision of oral care and an absence of prior appropriate measurement instruments or datasets, there are no prior reports of measuring the resultant quality of care among children across the states and territories in Australia. Such measurement is essential to

understand whether the care provision is meeting the expectations of the population that it aims to serve. Thus, this study aimed to evaluate variations across state and territories in the performance of oral care delivery for children in Australia as reported by their parents.

Materials and methods

This study used data from National Child Oral Health Survey (NCOHS) 2012- 2014. The Survey sampled children and their parents from all over Australia. The children included were between the age of 5 – 14 years. The sampling strategy used a two-stage stratified sampling design. The sampling strategy was designed to derive accurate population estimates for all of Australia and enable valid inter-state and territory comparisons. Sample weights were calculated separately for the states and territories to reflect the state and territory's population accurately. A total of 24,664 participants were included in NCOHS, with a total of 23,583 with valid questionnaire responses to the overall Survey. The Survey contained self-completed questionnaire and clinical examination by a calibrated dentist. An earlier publication has reported details of the sampling and weighting methodology (Do and Spencer 2016).

COPAS consists of 37 items that included nine dimensions from the National Health Performance Framework (NHPC 2001) that included effective, appropriate, sustainable, efficient, accessible, responsive, safe, capable, and continuous. These questions were related to the child's last dental visit. The parents' responses were recorded on a bipolar 5-point rating scale that ranged between strongly agree through neutral to strongly disagree. The COPAS score was calculated by adding the score from all the responses, while allowing 3 missing responses for individual items. The total score can vary between 0 to 148, and a higher score indicated better perceived quality of the performance of oral care. There were at least three items per

dimension. COPAS reported an internal consistency using of 0.95. The validity of COPAS was assessed using structural equation modeling, and this reported adequate model fit using root mean squared error of approximation, comparative fit index, Tucker-Lewis index, and coefficient of determination. There was also adequate convergent validity with the overall rating of oral care, as reported by an item measuring oral care provision ($\rho=0.59$). An overall rating of last dental visit was measured using a 5-point rating scale that ranged from Excellent to Poor.

Data analyses

Descriptive statistics were estimated for variables that were commonly related to satisfaction with oral care. These estimates were calculated while accounting for the hierarchical structure of the data and the sample weighting. The descriptive statistics included age, gender, equivalised total household income (ABS 2016), remoteness and visit to public care facility. Here the statistical models were aimed to assess the variation at state or territory level in COPAS overall score and its dimensions. From a causal perspective, the total effect of being in a state was considered as the exposure and the outcome was COPAS. As such, there is negligible chance of confounding bias (Greenland et al. 1999) for this relationship from demographic or health-related variables, as these demographic and health-related variables have a negligible chance of causing the exposure (states and territories). The effect of being in the state or territory is hypothesized to pass on through multiple mediators that may include many of the demographic and health-related variables along with possible interactions and effect modification. This conceptualization of the other variables not affecting bias was similar to its approach in prior research (Sanders et al. 2009). Apart from the causal consideration, there is also the relevance for the oral care system (influenced by the administrative agency of the states and territories)

being suitable for the people whom it aims to serve. Thus, adjusting for mediators would change the policy relevance of the analyses.

Of the overall sample, 15941 respondents with valid responses for COPAS were included in the analyses for COPAS. This shrinkage in the number of respondents was expected, as previous studies that assessed care from overall populations show that many children do not have adequate experience with care for their parents to respond adequately (da Silveira Pinto et al. 2016). To assess for the effect of missing data, the demographic variables (accounting for complex sample and weighting) were compared for both the overall group and the sample included in the analyses here (Appendix). The two groups (those with valid responses to COPAS and the overall population) were found to be similar. To further verify the results using another measure, the global rating of oral care (n=20971) was also modelled. Here mixed effects models (ordered logistic regression) were used to calculate the odds ratios. Mixed effects models using `meglm` command in STATA 14 (Gaussian, identity link) were used that account for the strata that the individuals were a part and sample weights were applied. The states and territories were also assessed with the dimensions that make up COPAS using similar models. SA was used as a reference category for the overall model for Australia, since the early descriptive statistics suggested that it may have the highest average COPAS score. Separate models were used with each of the nine dimensions of COPAS. Analyses were carried out using SPSS 24 and STATA 14.

Results

Descriptive statistics accounting for the complex sampling and sample weighting reported a similar distribution of age and sex among the various states and territories (Table 1).

Table 1: Descriptive statistics with the weighted means and percentages.

		ACT*	NSW*	NT*	QLD*	SA*	Tas*	Vic*	WA*
Age [mean(95%CI)]		9.4 (9.3 to 9.6)	9.5 (9.4 to 9.6)	9.4 (9.0 to 9.7)	9.5 (9.4 to 9.6)	9.7 (9.5 to 9.8)	9.6 (9.4 to 9.8)	9.5 (9.4 to 9.6)	9.6 (9.5 to 9.8)
Girls [percentage (95%CI)]		48.8 (43.6 to 54.1)	48.7 (45.4 to 52.1)	49.2 (43.2 to 55.3)	48.9 (46.5 to 53.0)	48.3 (43.6 to 53.0)	47.8 (43.5 to 52.0)	48.8 (45.4 to 52.3)	49.7 (46.3 to 53.1)
Global oral health [percentage (95%CI)]	Excellent	19.2 (16.8 to 22.0)	21.8 (19.8 to 24.0)	18.3 (14.9 to 22.2)	18.4 (16.5 to 20.4)	22.5 (20.0 to 25.1)	25.8 (22.3 to 29.6)	23.4 (21.5 to 25.4)	17.1 (15.2 to 19.2)
	Very good	39.4 (36.8 to 42.1)	36.0 (34.0 to 38.1)	34.1 (27.6 to 41.4)	36.1 (34.3 to 37.9)	40.5 (38.0 to 43.1)	38.1 (34.5 to 41.9)	37.8 (35.5 to 40.2)	39.8 (37.1 to 42.5)
	Good	29.7 (27.6 to 31.8)	29.0(27.0 to 31.1)	34.8 (27.8 to 42.4)	29.9 (28.0 to 31.9)	27.6 (24.7 to 30.7)	27.5 (24.0 to 31.3)	27.7 (25.5 to 30.0)	32.3 (29.5 to 35.2)
	Fair	9.2(7.6 to 11.0)	10.5 (9.3 to 12.0)	11.2 (8.3 to 15.0)	12.5 (11.1 to 14.1)	7.7 (6.3 to 9.4)	7.5 (6.1 to 9.1)	9.5 (8.1 to 11.1)	9.6 (8.0 to 11.6)
	Poor	2.5 (1.7 to 3.8)	2.6 (1.9 to 3.6)	1.6 (0.7 to 3.6)	3.1 (2.4 to 4.0)	1.8 (1.0 to 2.9)	1.2 (0.7 to 2.2)	1.7 (1.1 to 2.5)	1.2 (0.8 to 1.8)
Equivalent income [percentage (95%CI)]	1st quartile (Lowest)	15.7 (11.4 to 21.2)	30.9 (26.4 to 35.8)	13.7 (7.5 to 23.5)	30.2 (26.6 to 34.1)	24.2 (20.7 to 28.0)	36.2 (29.6 to 43.5)	30.9 (26.7 to 35.4)	25.5 (21.4 to 30.1)
	2nd quartile	15.7 (13.3 to 18.4)	22.7 (20.5 to 25.1)	22.8 (16.7 to 30.2)	26.0 (24.0 to 28.0)	29.4 (26.1 to 32.9)	26.9 (23.7 to 30.3)	24.4 (22.2 to 26.7)	20.8 (18.6 to 23.1)
	3rd quartile	22.9 (20.3 to 25.6)	19.7 (17.6 to 22.0)	29.8 (22.7 to 38.1)	21.6(19.8 to 23.5)	25.6 (22.8 to 28.7)	22.8 (18.9 to 27.2)	20.8 (18.6 to 23.3)	22.2 (19.8 to 24.8)
	4th quartile (highest)	45.8 (38.3 to 53.4)	26.6 (21.6 to 32.3)	33.8 (24.6 to 44.3)	22.2 (18.9 to 25.9)	20.8 (16.3 to 26.3)	14.1 (10.8 to 18.3)	24.0 (20.1 to 28.4)	31.5 (26.3 to 37.2)
Remoteness [percentage (95%CI)]	No	100.0	92.9 (87.9 to 95.9)	0.0	82.1 (75.8 to 87.1)	84.0 (74.8 to 90.4)	64.6 (50.4 to 76.6)	95.0 (91.5 to 97.1)	91.7 (81.4 to 96.5)
	Yes	0.0	7.2 (4.2 to 12.1)	100.0	17.9 (13.0 to 24.2)	16.0 (6.7 to 25.3)	35.4 (23.4 to 49.6)	5.0 (2.9 to 8.5)	8.3 (3.5 to 18.6)
Visit to public care facility [percentage (95%CI)]		49.2 (42.0 to 56.4)	27.3 (23.3 to 31.7)	78.3 (71.3 to 84.0)	56.1 (51.6 to 60.4)	48.3 (42.4 to 54.3)	74.1 (66.9 to 80.2)	34.3 (30.6 to 38.1)	71.4 (66.9 to 75.5)

*SA- South Australia, ACT=Australian Capital Territory, NSW- New South Wales, NT- Northern Territory, QLD- Queensland, Tas- Tasmania, Vic- Victoria, WA- Western Australia

The states with the highest proportion of those who were in the poorest income quartile were from NSW (30.9%), NT (30.2%) and Tas (36.2%). All those in ACT belonged to the metropolitan region and all those in NT belonged to more rural regions. Apart from NT, Tas had the largest percentage (35.4%) of those living in more rural regions. The states and territories with the lowest percentage of children visiting public dental care facility were NSW (27.3%) and Vic (34.3%).

Mixed effects model that assessed the total effect of states and territories on COPAS reported Tas and SA with the highest scores and the others overall had significantly lower scores (Table 2).

Table 2: Total effect of states and territories on COPAS and global satisfaction with oral care.

States and territories	COPAS			Global satisfaction with oral care	
	Regression Coefficient (95%CI)	P-value	Value of COPAS**	Odds Ratio (95% CI)	P-value
South Australia	0	-	121.37	1	
Australian Capital Territory	-6.18(-7.15 to -5.21)	<0.001	115.19	1.31(1.25 to 1.38)	<0.001
New South Wales	-5.66 (-6.80 to -4.53)	<0.001	115.7	1.64(1.55 to 1.75)	<0.001
Northern Territory	-6.19 (-7.25 to -5.13)	<0.001	115.18	1.43(1.35 to 1.52)	<0.001
Queensland	-8.68 (-9.87 to -7.50)	<0.001	112.68	2.04(1.90 to 2.18)	<0.001
Tasmania	-1.77 (-3.91 to 0.37)	0.10	119.59	0.86(0.78 to 0.94)	0.001
Victoria	-3.09 (-4.20 to -1.99)	<0.001	118.27	1.18(1.12 to 1.25)	<0.001
Western Australia	-5.13 (-6.49 to -3.77)	<0.001	116.24	1.34(1.26 to 1.42)	<0.001
Constant	121.37 (120.40 to 122.33)	-	-	-	-

*Mixed effects model accounting for sampling weights and clustering at stratum level.

*Higher scores signify better performance of oral care and vice versa for global satisfaction of care

** Predicted margins from the model.

Overall the COPAS scores were high with the measures for the groups ranging from 112.7 for Queensland to 121.4 for SA. A similar model using mixed effects ordered logistic regression with global rating for oral care found children in Tas reported a significantly lower odds for worse oral care than SA and all the other groups reporting higher odds for worse oral care (Table 2).

The model for effectiveness found that NT, Tas, and WA had significantly better scores than SA (Table 3). Whereas ACT, NSW, and Vic were similar to SA and Queensland was significantly lower than SA. Tas was similar to SA in the dimensions appropriate and efficient, while NT was similar to SA for appropriate, whereas all the other groups reported significantly lower scores for these dimensions.

Table 3: Total effect of states and territories on effective, appropriate and efficient.

States and territories	Effective Regression Coefficient (95%CI)	Appropriate Regression Coefficient (95%CI)	Efficient Regression Coefficient (95%CI)
South Australia	0	0	0
Australian Capital Territory	-0.15(-0.33 to 0.04)	-0.42(-0.51 to -0.32)	-0.53(-0.57 to -0.49)
New South Wales	0.11(-0.08 to 0.31)	-0.27(-0.41 to -0.13)	-0.31(-0.39 to -0.23)
Northern Territory	0.67(0.49 to 0.86)	-0.37(-0.48 to 0.27)	-0.82(-0.90 to -0.74)
Queensland	-0.40(-0.60 to -0.19)	-0.48(-0.60 to -0.36)	-0.22(-0.28 to -0.16)
Tasmania	0.38(0.16 to 0.59)	-0.02(-0.15 to 0.20)	-0.05(-0.14 to 0.03)
Victoria	0.15(-0.06 to 0.35)	-0.26(-0.42 to -0.10)	-0.20(-0.30 to -0.11)
Western Australia	0.37(0.14 to 0.61)	-0.40(-0.53 to -0.27)	-0.70(-0.82 to -0.58)
Constant	10.88(10.69 to 11.06)	13.08(12.98 to 13.18)	14.24(14.20 to 14.28)

*Mixed effects model accounting for sampling weights and clustering at stratum level.

*higher scores signify better performance of oral care

Table 4 assessed the differences between the jurisdictions with regards to the dimensions responsive, accessible and safe. Here again, Tas was similar to SA on

all three dimensions, and NT and WA were similar to SA for the dimension responsive. NT reported worse scores than SA for accessible and safe. All the other groups reported lower scores than SA for the three dimensions.

Table 4: Total effect of states and territories on responsive, accessible and safe.

States and territories	Responsive Regression Coefficient (95%CI)	Accessible Regression Coefficient (95%CI)	Safe Regression Coefficient (95%CI)
South Australia	0	0	0
Australian Capital Territory	-0.60(-0.69 to -0.51)	-0.66(-0.85 to -0.48)	-0.25(-0.38 to -0.14)
New South Wales	-1.18(-1.28 to -1.07)	-1.02(-1.28 to -0.76)	-0.49(-0.60 to -0.38)
Northern Territory	-0.09(-0.18 to -0.00)	-0.88(-1.09 to -0.67)	-1.07(-1.25 to -0.88)
Queensland	-0.85(-0.96 to -0.74)	-0.88(-1.09 to -0.67)	-0.91(-1.04 to -0.78)
Tasmania	0.07(-0.08 to 0.23)	0.24(-0.04 to 0.52)	0.21(0.09 to 0.33)
Victoria	-0.66(-0.77 to -0.56)	-0.52(-0.78 to -0.27)	-0.25(-0.37 to -0.13)
Western Australia	-0.40(-0.51 to 0.29)	-0.33(-0.55 to -0.10)	-0.67(-0.78 to -0.55)
Constant	13.27(13.18 to 13.36)	19.63(19.44 to 19.81)	13.84(13.75 to 13.93)

*Mixed effects model accounting for sampling weights and clustering at stratum level.

*higher scores signify better performance of oral care

The analyses for the dimensions continuous, capable, and sustainable are reported in Table 5. Here Tas and Vic reported scores similar to SA for all three dimensions.

All the other groups reported lower scores than SA for the other dimensions.

Table 5: Total effect of states and territories on continuous, capable and sustainable.

States and territories	Continuous Regression Coefficient (95%CI)	Capable Regression Coefficient (95%CI)	Sustainable Regression Coefficient (95%CI)
South Australia	0	0	0
Australian Capital Territory	-0.44(-0.54 to -0.35)	-0.33(-0.39 to -0.26)	-1.66(-1.77 to -1.54)
New South Wales	-0.48(-0.59 to -0.36)	-0.19(-0.27 to -0.11)	-1.03(-1.23 to -0.84)
Northern Territory	-0.34(-0.46 to 0.21)	-0.28(-0.50 to -0.07)	-1.31(-1.56 to -1.05)
Queensland	-0.74(-0.85 to -0.63)	-0.27(-0.37 to -0.17)	-2.57(-2.72 to -2.41)
Tasmania	0.08(-0.12 to 0.28)	0.14(0.03 to 0.24)	-0.24(-0.50 to 0.02)
Victoria	-0.02(-0.13 to 0.10)	-0.03(-0.15 to 0.08)	-1.38(-1.54 to 1.23)
Western Australia	-0.49(-0.60 to -0.38)	-0.49(-0.58 to -0.40)	-0.49(-0.67 to -0.31)
Constant	17.93(17.83 to 18.02)	13.26(13.20 to 13.32)	11.95(11.83 to 12.07)

*Mixed effects model accounting for sampling weights and clustering at stratum level.

*higher scores signify better performance of oral care

Discussion

The participants reported overall high COPAS scores. This suggests that a high rating of the performance of oral care was experienced by most children in Australia. But the level of COPAS was not uniform between the states and territories, where Tas and SA were similar and the individuals in the rest of the states and territories reported overall lower scores. The overall congruence of these results with the results measuring the total effect of states and territories as a global rating of oral care lent further credibility to the findings of this study. This assessment of the global scores along with the analyses of missing values (Appendix) suggests that the effect of having fewer respondents in the analyses was unlikely to have caused a large amount of bias.

The measurement of the overall scores only gave a partial description of the quality of care. The dimensions that make up the overall measure also plays an important role (Davies and Ware 1981). The overall trend suggested that there was similarity between Tas and SA on overall COPAS and most dimensions. Effectiveness was a notable difference, where individuals in Tas, WA and NT reported higher scores than SA, and rest of the states and territories were either similar or worse than SA. Effectiveness is an important outcome that is quantified in various ways in analyses of outcomes (Drummond et al. 2015). Similarly, access is another important dimension that has been examined in earlier research (Edelstein and Chinn 2009). In the current study, individuals in Tas and SA reported similar access, while the other regions reported lower levels of access to dental care. Though these are important findings and they describe important aspects of the care delivery system, the children's experience of the oral care is not restricted to effectiveness or access (Nair et al. 2018a). The children in most other states and territories scored lower in the other dimensions than the children in SA. A few exceptions were noted, where children in NT were similar with regard to the dimension responsive, and those in Vic were similar for the dimensions continuous and capable. One of the major differences in the oral care systems among the states and territories is the extent of provision of public dental care either through the SDS or CDS, and their criteria for eligibility and the co-payments that are applied (Do and Spencer 2016; NACDH 2012b). The effect of public versus private care provision and the interaction between the two have been debated in the past (Rosenthal and Newbrander 1996). A current systematic review suggests that evidence supporting private care resulting in increased efficiency and effectiveness is lacking (Basu et al. 2012).

This study reported on the differences in COPAS scores and its nine dimensions for children in various states and territories. The transmission of the effect of living in a state or territory on COPAS may have many pathways. Such pathways have not been defined adequately in previous studies, except as a group of possible covariates that do not differentiate between confounding, mediation or other relationships. Since this paper assessed the effect of state and territories on the performance of oral care delivery for children in Australia, adjusting for mediating or moderating pathways would give an answer to a different question than the one that this paper sought (Greenland et al. 1999). The similarity in age and gender after using sampling weights (that assign the representative proportions of the demographic variables to the states and territories) suggests adequate exchangeability on these demographic variables. The differences in the other variables suggests the differences between the states in structural and economic terms and many of these could result in potential mediation or interaction (ABS 2018; Sanders et al. 2009). Since the states and territories cater to their populations, it makes sense to look at its ability to do so absolutely and relatively in comparison to others. Apart from this, the scores conditioned on mediators would also not reflect the overall population and its experience but would instead assess a causal pathway that depends on the mediators that the analyses are conditioned on. The total effect of the states and territories on the performance of oral care for children (COPAS) is relevant at this level to where the decisions in the political system are made regarding the funding for public dental care (SCARC 1998).

The large sample size of the study can report some small but significant estimated differences that can be irrelevant to interpretations at an individual level. This can happen due to the higher power of the larger studies. However, smaller differences

applied to larger groups still require attention, as is the case with some major dental diseases. The magnitude of differences found here were also similar to the proportional differences found between the various healthcare systems in four countries as measured by the impact of income on OHIP-14 scores (Sanders et al. 2009). This suggests similarity in response to variations in systems, though as described in Figure 1, it is important to remember that the quality of life measure and the measure of the performance of oral health care system are distinct in the concepts measured.

Though the perspective taken in this study was important as a baseline for assessing the effect of living in a state or territory on the performance of oral care in Australia, understanding the mechanisms that drive it would be equally important to build policy interventions to tackle the differences across these regions and further improve the performance of oral care. This is especially true, since medium sized states with extensive school dental programs had the highest COPAS scores. The mechanism of how this occurs needs to be examined in the future. The analyses came from a cross-sectional dataset, and there could be some misclassification bias due to internal migration of people from one state to another. But the effect of such internal migration was assumed to be small, as the net migration in Australia is very small (ABS 2017).

Conclusions

The overall ratings for the performance of oral care (COPAS) was high. Tasmania and South Australia had the highest rating for COPAS and in most dimensions.

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6.3 Appendix

Difference between the overall sample and those with valid COPAS scores (not missing)

Variable	Category	Overall	Not missing
Age [mean(95%CI)]		9.5 (9.4-9.7)	10.1 (9.9-10.2)
Girls [percentage (95%CI)]		48.8 (47.3-50.4)	49.6 (47.7-51.4)
Equivalentized income [percentage (95%CI)]	1st quartile (Lowest)	29.5 (27.5-31.7)	27.8 (25.9-29.9)
	2nd quartile	24.0 (22.9-25.1)	23.7 (22.6-25.0)
	3rd quartile	21.1 (20.1-22.3)	21.8 (20.6-23.1)
	4th quartile (highest)	25.2 (22.9-27.6)	26.6 (24.2-29.1)
Remoteness [percentage (95%CI)]	No	89.1 (86.7-91.1)	88.7 (86.3-90.7)
	Yes	10.9 (8.9-13.3)	11.39.3-13.7)
Visit to public care facility [percentage (95%CI)]		43.2 (40.6-45.9)	42.6 (40.1-45.3)

Weighted means and percentages for the overall group and the sample included in the study.

7 Empirical study 3

Private dental care benefits non-Indigenous children more than
Indigenous children.

Status: Paper submitted to Health Services Research.

Statement of Authorship

Title of Paper	Private dental care benefits non-Indigenous children more than Indigenous children.		
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Name of Principal Author (Candidate)	Nair, R		
Contribution to the Paper	Developed the methodology, conceptualised the analyses, carried out the analyses, prepared the primary draft and critically reviewed the draft.		
Overall percentage (%)	80%		
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.		
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

- i. the candidate's stated contribution to the publication is accurate (as detailed above);
- ii. permission is granted for the candidate to include the publication in the thesis; and
- iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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7.1 Linkage to the body of work

The preceding work in this thesis quantified the measurement properties of COPAS and used this measurement to quantify one of the larger variations in the oral care system in Australia, namely, the variations between states and territories (Chapter 6). That paper suggested that the distribution of private and public care may play a role in the level of the performance of oral care. This effect has not been examined, especially from a national perspective. We also know that the Aboriginal and Torres Straits Islanders (Indigenous Australians) face health inequities, including oral health inequities. But the mechanism of such an effect has not been explored in the past. For the first time reported, this study evaluated the modification of the effect of public versus private care on the performance of oral care due to indigenous status of the children in Australia, and thus assessed a mechanism that can enable the oral health inequity.

7.2 Highlights

1. There was evidence of effect modification of attending public versus private care on the performance of oral care among children due to indigenous status, where the non-Indigenous children receive increased performance in oral care while visiting private facilities versus public facilities, while the Indigenous children do not receive such an increase in performance.
2. Overall, there were similarities in the domains of effective and efficient among the Indigenous and non-Indigenous children, where the private care was not better than private care.

Title: Private dental care benefits non-Indigenous children more than Indigenous children.

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Keywords: Health Equity, Health Care Evaluation, Health Services, Effect Modifier, Quality of Healthcare, Oral Health.

Abstract

Objective: This study aimed to assess the effect of visiting a public or private dental care facility on the performance of oral care experienced by Indigenous versus non-Indigenous children in Australia.

Data source: Data from the National Child Oral Health Study 2012-2014 was used with a representative sample of children from all the states and territories of Australia.

Study Design: Effect modification between visiting a public or private facility on the performance of oral care due to Indigenous status of the children was calculated. The performance of oral care was measured using a 37-item instrument.

Results: Effect modification on the additive scale showed that there was an improvement of 4.46 points (95%CI=0.11, 8.82) between private and public care facilities among non-Indigenous children that was not found among Indigenous children in Australia. Similar trend was found among non-Indigenous children for the nine domains measured, except for Effectiveness that was similar for both private and public facilities Efficient that was higher for public facilities.

Conclusion: This study found a higher performance of oral care in private care locations among non-Indigenous children versus Indigenous children.

Keywords: Health Equity, Health Care Evaluation, Health Services, Effect Modifier, Quality of Healthcare, Oral Health.

Introduction

Healthcare systems aim to meet the health-related needs of individuals under its care.^{1,2} Systems that provide such care provision are resource intensive, with resource allocation organized in a myriad of ways.³⁻⁵ Resource allocation involves an assertion of the constituents who will pay for the care provision and those who will receive it.⁶ A broad categorization of such care delivery can be divided into those receiving public or private funding; the latter can often be through private insurance. In both private and publicly funded care, the group receiving care may not include those who pay for it. A majority of the spending on oral care in Australia occurs in the private sector.⁴ The oral care for children is an exception, with a more substantial proportion of public spending. In this context, Commonwealth funding (funding from the Federal Government) is passed on to the states and territories, who in turn have the discretion to use such funding to provide public dental care for children.⁷ This has resulted in a heterogeneous arrangement of oral care for children.⁸ A large amount of the heterogeneity results from differences in the extent of public care that is available in each of these regions and the effects of these differences are currently unassessed.

Donabedian summarized the political philosophies around private, public and mixed models in healthcare in vaguely libertarian and egalitarian perspectives.⁹ In the case of the egalitarian system, there is usually a need to limit demand.⁶ In the libertarian system, there is often a need to curtail oversupply. In the case of mixed strategies, a combination of private and public funding systems emerge. These mixed systems often lack clear reasoning for demarcation of what is included in the public and private care systems, and the overall population or sub-groups may not benefit from some demarcations versus others. Thus, the optimization of efficiency in mixed systems need to aim for positive outcomes for the people under its care.¹⁰

While assessing the perceived quality of care, a greater expectation of quality for private care has been reported.¹¹ But the presupposition that there is better quality of care due to higher efficiency or effectiveness in the private sector may not be correct.¹² Both the public and the private care systems come with unique drawbacks that need to be assessed for individual situations.^{5,6,13} Though the mixed systems can benefit from synergies between coexisting public and private systems, the two systems could also interact in ways that can negatively impact each other.¹⁴ In Australia, an increase in the number of private care facilities has not always resulted in synergistic improvements in patterns of utilization of care.¹⁵

Dental diseases that affect children are among the most prevalent diseases worldwide. In a worldwide ranking of all diseases, dental caries in permanent and primary teeth were the 1st and 5th most prevalent diseases.¹⁶ Although the common dental diseases are preventable,¹⁷⁻¹⁹ their prevalence continues to be high.^{20,21} Consequently, spending on dental diseases form a significant proportion of overall healthcare spending in many regions.^{3,4,22} Approximately 113.6 billion USD was spent on dental care in the US with 88% of that amount paid out of pocket or through private insurances.³ In the European Union, the percentage of public expenditure for dental care ranged between 0 to 65%.²³ There the percentage of dental care expenses covered by public services was linearly related to missing dental visits. In 2013, the Australian public spending accounted for 25.4% of the total spending on dental care.²⁴ Approximately 60% of the children aged 5-14 years visited public clinics.²⁵ Prior studies that have assessed the performance of oral health systems have used proxies such as missed appointments or inadequate appointments.²⁶ Such items do not examine the care provision system comprehensively. Our current literature review suggests that there is a lack of studies that report on the differences in oral care provision between private and public dental care visits among children. This information is currently essential, as there are recommendations in Australia that the state funded facilities should not be favored.²⁷

Such a lack of studies is even more critical among the Aboriginal and Torres Strait Islanders (Indigenous Australians) who face numerous health inequities.²⁸ Among Indigenous Australian children, those who experience greater discrimination were less likely to have visited a dentist.²⁶ They were also more likely to have had dental extractions and to have undergone dental procedures under general anesthesia than their non-Indigenous counterparts.²⁹ Similar inequities are faced by Indigenous populations in various Australian jurisdictions, making measuring the levels of inequities a vital principle of the ‘Closing the Gap’ initiative.^{28,30} It is imperative to identify the structural causes of inequities that can help Australian states and territories plan their healthcare systems more equitably.

Since healthcare systems aim to meet the healthcare needs of people under their care, the evaluation of the differences between the private and public care facilities needs a measurement from the perspective of the very individuals who are under the purview of these healthcare systems. Quality of care measured from the perspective of the patients or their caregivers would be appropriate for such a measurement.³¹ This is especially important because healthcare providers often act as an agent to help make a choice for individuals who are seeking care,⁹ and their ability to act as adequate proxies are unassessed. The Child Oral-care Performance Assessment Scale (COPAS) was developed by the NCOHS investigators (LGD and AJS) to enable such a measurement using the dimensional framework described by the national health performance framework.⁷ The unassessed differences between (1) public and private care facilities, (2) along with the recommendation to reduce public funded facilities, and (3) the health inequities faced by Indigenous Australians necessitates an understanding of the effect modification of the care settings on the performance of oral care due to Indigenous status of children. Thus, this study aims to assess the effect modification due to Indigenous status on the effect of visiting either a private or public care facility on COPAS for both Indigenous and non-Indigenous children in Australia.

Materials and Methods

This manuscript follows STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) guidelines.³² Data was sourced from the National Child Oral Health Study 2012-2014 (NCOHS).²¹ The target population was children in Australia aged 5-14 years. A representative sample of children was sampled using a two-stage stratified random sampling procedure. Children were sampled from primary and secondary schools, with 841 schools participating in the survey. Self-administered questionnaires were given to participating parents or guardians, where they reported various factors that either cause or protect common dental diseases. These care-givers additionally provided information regarding professional oral care received by the participating children and oral health-related information. A total of 24,664 children participated, with 23,583 valid responses from their care givers. The sampling technique was intended to reflect the overall Australian child population and the population in each state and territory. To this end, the sample was weighted to adjust for response bias. The weights were based on both child and family characteristics that reflect national and state-level demographics.

In this study, the type of clinic used for the last dental visit by the participating child was reported by their parent or guardian. Public clinics included school dental services, public hospitals, and community health clinics, while private clinics included private dental clinics and private health fund clinics. Among the respondents, 2624 reported that they did not know, or the question was not applicable to them. Data from these participants were not included in this study. The outcome of interest was the quality of performance of oral care as measured using COPAS. COPAS is a 37-item scale that includes nine dimensions that was a part of the self-administered parental questionnaire. The dimensions of COPAS are Effective, Appropriate, Efficient, Responsive, Accessible, Safe, Continuous, Capable and Sustainable. At least three items identified each dimension. The items in-turn recorded responses on a

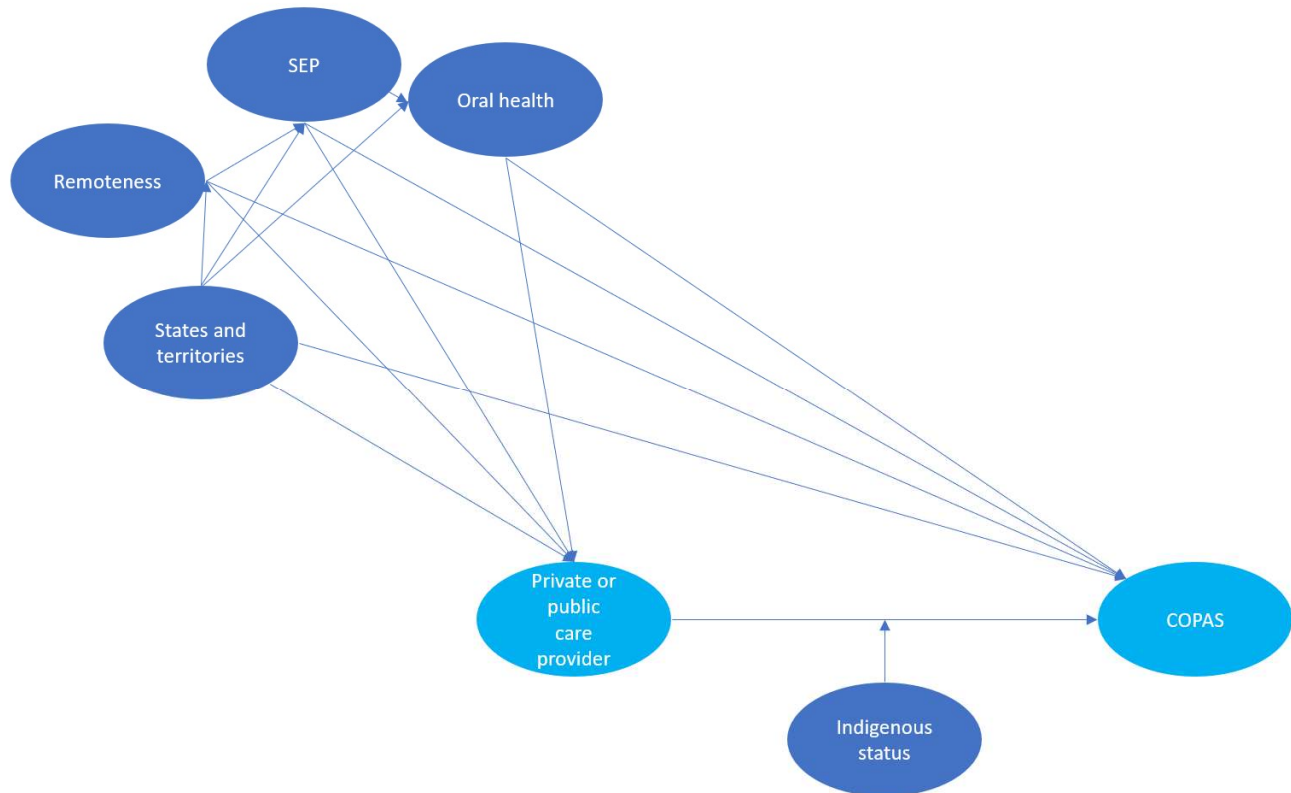
five-point rating scale, where the agreement to the statements ranged from strongly agree through neutral to strongly disagree. A summative score that allowed for up to three missing values was calculated that depicts the COPAS score, where the scores ranged from 0-148. A higher COPAS score indicates better quality of performance of oral care. Earlier analyses found adequate internal consistency (Cronbach's $\alpha=0.95$) for COPAS. There was also adequate factor validity assessed using structural equation models (Root mean squared error of approximation = 0.06, Comparative fit index = 0.90, Tucker-Lewis index = 0.89, and Coefficient of determination = 0.99) and appropriate convergent validity with overall rating of previous dental visit ($\rho=0.59$). The overall rating of previous dental visit was measured using a 5-point rating scale that ranged from excellent to poor. Among the participants, 15,941 respondents had valid COPAS scores. These participants were included in this study. The effect of the missing values was assessed using the rating of last dental visit and factor score of COPAS (Appendix). Both the rating of the last dental visit and the factor score for COPAS had 20,971 valid responses. Fewer missing responses were expected for the overall rating for last dental visit, as concepts such as continuity of care were not necessary for its response. The factor scores for COPAS derived from structural equation model for COPAS with its hypothesized dimensionality and the estimation accounted for missingness (full-information maximum likelihood estimation).

Data analyses

Descriptive statistics were reported with sample weighting and accounting for clustering at the stratum level. The confounding structure comprised of variables related to socioeconomic position, remoteness, oral health status, and states and territories. Socioeconomic position was assessed using income, education, equivalised income³³ and parent's country of birth. Oral health rating was another

variable that was adjusted for in the models, and it was measured on a five-point rating scale that ranged from excellent to poor.

Figure 1: Directed acyclic graph for the causal relationship between private or public care givers and COPAS.



SEP – Socioeconomic Position comprised of Parental Education, Indigenous Status, Equivalised Income and Country of Birth.

The analyses were carried out after stratifying the sample into Indigenous and non-Indigenous children. Mixed effects models were used for the assessment of the effect of the choice of private or public care facility on COPAS and its nine dimensions. Models were checked for interactions and exponential variables. Then on the overall sample (without stratification), effect modification was evaluated for the extent of change in the overall effect of public versus private care facilities on COPAS and its dimensions due to Indigenous

status. Currently accepted methods were used for the calculation of effect modification on continuous and dichotomous value for COPAS,^{34,35} while adjusting for all the confounding variables used in the stratified models. As recommended, both additive and multiplicative effects were estimated here. A multiplicative term was entered in the regression model with the continuous outcome to assess the additive effects. Whereas a log-linear model was used, and the coefficient was exponentiated for assessing the multiplicative effects. COPAS was then dichotomized at a score of 113, which corresponded with the average value of COPAS among Indigenous children who visited public care. For the dichotomized scale, relative excess risk due to interaction (RERI) and its confidence intervals³⁶ were calculated. Here $RERI = \text{Incremental Rate Ratio (IRR) among those who were non-Indigenous and went to a private facility} - \text{IRR among non-Indigenous who went to a public facility} - \text{IRR among Indigenous children who went to a private care facility} - 1$. Stata IC version 14.2 was used for statistical analyses.

Results

Descriptive statistics are detailed in Table 1 for Indigenous and non-Indigenous children describing the distribution of their visit to either public or private dental care facilities. Indigenous and non-Indigenous children had similar ages for those visiting public and private facilities, with an average age between 9.5 to 9.9 years. Similarly, about half of the Indigenous and non-Indigenous girls visited both private and public dental care facilities. A similar percentage of Indigenous children (8.8 vs 8.2) and non-Indigenous (37.8 vs 36.8) children with one or more parent born overseas visited public versus private care respectively. Though there is a smaller percentage of Indigenous children with one of more parents born overseas versus the same among non-Indigenous children. Common trends were found among Indigenous and non-Indigenous children, where those with lower levels of

parental education and equivalised income were more likely to visit public care facilities and vice versa.

Table 1: Descriptive statistics of the study sample.

Variable	Indigenous		Non-Indigenous	
	Public	Private	Public	Private
Age [mean(95%CI)]	9.8 (9.5, 10.2)	9.5 (8.6, 10.3)	9.7 (9.6, 9.9)	9.9 (9.7, 10.2)
Female [Percentage(95%CI)]	52.2 (46.5, 57.9)	54.5 (42.5, 65.9)	48.9 (47.1, 50.7)	49.1 (46.6, 51.7)
One or more parents born overseas	8.8 (5.8, 13.3)	8.2 (4.0, 15.9)	37.8 (35.3, 40.3)	36.8 (34.2, 39.4)
Remoteness				
	Yes			
	37.5 (27.3, 48.9)	14.9 (8.7, 24.5)	14.4 (11.7, 17.5)	7.4 (5.7, 9.5)
Highest parental education [Percentage(95%CI)]				
	High School or less			
	56.7 (49.5, 63.6)	31.7 (20.6, 45.5)	36.1 (34.2, 38.0)	18.4 (16.6, 20.3)
	Some vocational training			
	22.9 (18.2, 28.4)	26.1 (15.7, 40.3)	25.2 (23.6, 26.8)	20.6 (18.9, 22.4)
	Some university or college			
	20.3 (15.5, 26.2)	42.1 (31.0, 54.1)	38.7 (36.7, 40.8)	61.1 (58.2, 63.9)
Equivalised income [Percentage(95%CI)]				
	1st quartile (Lowest)			
	63.1 (56.5, 69.2)	20.5 (12.7, 31.3)	41.9 (39.5, 44.3)	15.1 (13.5, 16.8)
	2nd quartile			
	21.1 (16.4, 26.7)	30.4 (20.5, 42.5)	25.7 (24.2, 27.1)	23.1 (21.5, 24.8)
	3rd quartile			
	12.5 (9.0, 17.1)	31.7 (19.8, 46.6)	18.1 (16.9, 19.4)	25.1 (23.5, 26.8)
	4th quartile (highest)			
	3.3 (1.9, 5.7)	17.4 (9.5, 29.6)	14.4 (12.8, 16.0)	36.7 (33.5, 40.0)
Oral health rating [Percentage(95%CI)]				
	Excellent			
	12.4 (8.7, 17.3)	29.7 (20.6, 40.7)	14.6 (13.4, 15.8)	26.5 (25.2, 27.9)
	Very good			
	26.4 (21.6, 31.8)	37.7 (27.2, 49.6)	36.1 (34.6, 37.7)	39.7 (38.2, 41.2)
	Good			
	37.4 (31.4, 43.7)	23.6 (15.6, 34.2)	33.3 (31.8, 34.9)	24.9 (23.4, 26.3)
	Fair			
	18.3 (13.8, 24.0)	8.5 (3.9, 17.3)	13.0 (12.0, 14.2)	7.7 (6.9, 8.7)
	Poor			
	5.5 (3.4, 8.7)	0.5 (0.1, 3.4)	3.0 (2.4, 3.6)	1.2 (0.2, 1.6)

*Estimates were calculated while accounting for clustering at stratum level and sample weighting.

But the overall percentage of those with lower parental education and equivalised income was higher among Indigenous children. A higher percentage of those with an excellent rating for overall dental health visited a private dental care facility, with similar trends among those who reported very good. However, those with poor or fair ratings were more likely to have visited public dental care. It is also worth noting that a larger percentage of Indigenous

children (67%) than non-Indigenous children (42%) completed their last dental visit at a public care facility.

The effect of visiting public versus private dental care facilities on COPAS and its dimensions among Indigenous children is detailed in Table 2. The overall COPAS scores for private and public care facilities were similar with a difference of 1.27 and confidence intervals distributed roughly equally around 0. Similar results were also found for the various dimension of COPAS, where the subscale values were quite similar and often favored public over private care facilities with no statistically significant differences.

The effect of visiting public versus private care facilities on COPAS among the non-Indigenous children was significantly different with private care scoring 4.62(95%CI=3.67, 6.18) points higher than public care (Table 3). Similarly, private care scored higher than public care for most dimensions, with the exceptions being 'Effective' and 'Efficient' domains. The scores for Effective were very similar for public and private care (10.78 and 10.73, respectively). Whereas public care facilities scored higher for efficient (13.12) versus private care (12.79).

Using continuous COPAS score, the effect modification on the additive scale(95%CI) was 4.46(0.11, 8.82), and on the multiplicative scale(95%CI) was 1.06(1.01, 1.13). The measurement of additive effect modification using RERI(95%CI) was 0.17(0.01, 0.33). This was indicative of a 17% excess chance of higher performance of oral care among non-Indigenous children versus Indigenous children in Australia. The direction of the value of effect modification on the additive and multiplicative scales, along with the IRR values suggests that higher performance of private clinics among non-Indigenous children in Australia versus public care, but not among the Indigenous Australians (Table 4).

Table 2: Total effect of public versus private dental care provision on COPAS and its dimension amongst Indigenous children in Australia (n=503).

Scale	Care provider	Indigenous (Unadjusted)			Indigenous (Adjusted)		
		Regression coefficient (95%CI)	Value of Scale	P-value	Regression coefficient (95%CI)	Value of Scale	P-value
COPAS Range:0-148	Public	0	113.03	0.41	0	115.38	0.76
	Private	3.73 (-4.64, 11.39)	116.40		-1.27 (-9.50, 6.97)	114.11	
Effective Range: 0-16	Public	0	11.08	0.43	0	10.60	0.60
	Private	-0.36 (-1.25, 0.53)	10.72		-0.33 (-1.56, 0.91)	10.27	
Efficient Range: 0-16	Public	0	12.91	0.44	0	11.46	0.23
	Private	-0.45 (-1.56, 0.68)	12.47		-1.00 (-2.63, 0.64)	10.46	
Appropriate Range: 0-16	Public	0	11.50	0.82	0	11.51	0.85
	Private	-0.12 (-1.18, 0.94)	11.38		-0.10 (-1.17, 0.96)	11.40	
Sustainable Range: 0-16	Public	0	13.51	0.18	0	11.18	0.25
	Private	0.85 (-0.40, 2.11)	14.36		0.66 (-0.47, 1.78)	11.84	
Access Range: 0-24	Public	0	16.39	0.24	0	15.89	0.34
	Private	0.76 (-0.51, 2.02)	17.15		-0.75 (-2.29, 0.79)	15.14	
Responsive Range: 0-12	Public	0	8.81	0.81	0	8.75	0.45
	Private	0.11 (-0.77, 0.98)	8.92		-0.33 (-1.89, 0.52)	8.42	
Safe Range: 0-16	Public	0	12.53	0.85	0	12.33	0.55
	Private	0.11 (-1.03, 1.25)	12.64		-0.32 (-1.40, 0.74)	12.00	
Capable Range: 0-16	Public	0	10.81	0.29	0	12.69	0.79
	Private	0.59 (-0.50, 1.68)	11.40		0.16 (-1.00, 1.31)	12.85	
Continuous Range: 0-16	Public	0	10.64	0.01	0	9.09	0.25
	Private	1.68 (0.39, 2.98)	12.32		0.93 (-0.64, 2.50)	10.01	

*Separate mixed effects models were used for each of the public-private comparisons. Where applicable, each model controlled for parental education, equivalised income, country of birth, oral health rating, remoteness, and states and territories.

*Value of Scale was calculated from the predicted margins of the respective models.

Using continuous outcome, the effect modification on additive scale(95%CI) was 4.46(0.11, 8.82), and on multiplicative scale(95%CI) was 1.06(1.01, 1.13). The measurement of effect modification using RERI (0.17(0.01, 0.33)) was indicative of a 17% excess chance of higher performance of oral care among non-Indigenous children versus Indigenous children in Australia. The direction of the value of effect modification on the additive and multiplicative scales, along with the IRR values suggests that higher performance of private clinics among non-Indigenous children in Australia versus public care, but not among the Indigenous Australians (Table 4).

Table 4: Effect modification for the extent of change in the effect of public versus private care on COPAS due to the Indigenous status among children in Australia (n=13,878).

	Indigenous	non-Indigenous
	IRR	IRR
	(95%CI)	(95%CI)
Visited public care facility (reference group)	1.00	0.98
Visited private care facility	0.99 (0.84, 1.17)	1.14 (1.04, 1.25)

Here the relative excess risk calculated from Poisson regression on dichotomised COPAS scale (below 113, or at and above 113) with exponential estimates were used to calculate excess risk with RERI (relative excess risk due to interaction). Here higher IRR indicates better performance. Here RERI= 0.17 (0.01, 0.33) after controlling for parental education, equivalised income, country of birth, oral health rating, remoteness and states and territories. RERI >0 is indicative of effect modification.

Discussion

After adjusting for the confounding variables, there was a perceived higher performance in oral care when visiting private facilities among non-Indigenous children in Australia that was not shared by the Indigenous children. This difference in effect was found in the stratified analyses, where the adjusted mixed-effects models for COPAS and its domains show similar

values for private and public care with point estimates that often-favored public care for Indigenous children. Whereas the non-Indigenous children visiting private care facilities had higher COPAS scores and domain scores, except for the domains Effective and Efficient. The mixed effects models on a nationally representative sample provide insight into the adjusted values for the different groups separately. Here the models account for their respective confounding structure and not a common confounding structure. The assessment of effect modification using continuous and dichotomous outcomes, on the other hand, adjusts for a common confounding structure. It is recommended that both additive and multiplicative effect modification be tested at the same time.³⁴ The interpretation of additive effect modification extends to the presence and the direction of effect, where the estimate > 0 indicates effect modification and the direction of the effect. In this case, both the additive model using continuous outcome and using dichotomous outcome (with RERI) supports the results from the stratified analyses. Similar results were also found from the multiplicative effect modification. These results provide evidence for the modification of effect due to Indigenous status, while effectively maintaining exchangeability in all the comparisons. All the results are consistent in indicating that, unlike the non-Indigenous children, there were no gains in performance of oral care for the Indigenous children from visiting private care facilities over public care facilities.

These results are essential, as a previous study found that the dental visitation was lower among Indigenous Australians who reported greater discrimination.²⁶ Indigenous children in Australia also face a significantly greater disease burden with about 60% higher proportion of children who were 6-8 years of age with dental caries experience and a greater experience of dental caries than the national average (mean DMFT of 3.4 vs 2.0).²⁹ This study provides key evidence related to the difference in perceived performance of professional care provision for Indigenous Australians that can explain a part of the differences in the oral condition that was

found in the previous studies. The study suggests that an increase in the provision of care from private facilities may increase oral health inequities that further marginalize Indigenous Australians. Such a differential effect also alludes to structural racism,³⁷ where often color-blind policies without an explicit intent of discrimination can persecute minority communities.^{38,39} In the context of current suggestions that the state would be better off with not providing care directly through its facilities,²⁷ this could result in increasing inequities. The overall scores for COPAS and its domains were high in both groups that attended a public or private dental care facility, suggesting a high level of reported performance of the oral care system. This was similar to the findings in other studies across various settings that consistently found similar results among adult patients.⁴⁰⁻⁴³ A previous study had assessed the difference in dental satisfaction using the dental satisfaction scale and the findings were similar to those reported in the current study with similar values for the overall index and the two sub-scales (cost and access) favored public service provision through school dental services.⁴¹ Though the overall construct measured by COPAS and dental satisfaction index is similar, the theoretical basis for scale construction and the items are different.³¹ This previous study⁴¹ was conducted in one State in Australia (South Australia) and the current study comprised a national sample. The current study also found that the care facilities were equally effective with care provision and public care was more efficient than private care among non-Indigenous children. This finding was similar to another Australian study that found no improvement in effectiveness and efficiency associated with private care versus public care.¹²

While interpreting the results, it is important to consider that despite the representativeness of the sample, the number of participants included in the Indigenous sample was much smaller than the non-Indigenous group. But the tendency of the central estimates in the Indigenous group was more likely to favor public care (though with wide confidence intervals). This,

along with the consistency of the results in the regression estimates for additive and multiplicative effects for the continuous outcome and the RERI from dichotomized outcome lends credence to the modification of effect reported. It is also important to concede that the definition of health, healthcare, and performance of healthcare operationalized in this paper were not adapted to the values held by the diverse Indigenous communities in Australia. Such an adaptation was recommended⁴⁴ and should be a future goal for more appropriate measurement of health states, care provision and its performance.

Conclusion

This study found evidence of effect modification of private versus public care facilities on the performance of oral care with an increased chance of higher performance of oral care in private dental care facilities among non-Indigenous children versus Indigenous children in Australia.

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8.1 Appendix

Stratified analyses were also carried out with the rating for last dental visit, that had a higher number of valid responses. This was carried out to assess the appropriateness of the estimates and the direction of the estimates found in the COPAS scores. Here the analyses of the effect of private versus public care on overall rating of last dental visit used ordinal mixed effects models to calculate odds ratios that controlled for parental education, equivalised income, country of birth, remoteness, and states and territories. The overall ratings for last dental visit also found similar results with no significant results among the Indigenous children (OR(95%CI) = 1.4(0.66, 2.98) and a significantly better rating for private care among the non-Indigenous children (OR(95%CI) = 1.82(1.61, 2.06). These were similar to the results found in tables 2 and 3.

Following this, assessment was carried out using the rating of last dental visit and factor score of COPAS from structural equation modelling that accounted for missingness full-information maximum likelihood estimation. Both the variables were dichotomized at their values found appropriate for Indigenous children who visited public care facilities.

1. Effect modification for the extent of change in the effect of public versus private care on rating of last dental visit (fair, poor, good versus very good, excellent) due to the Indigenous status among children in Australia (n=18,138).

	Indigenous	Non-Indigenous
	IRR	IRR
	(95%CI)	(95%CI)
	1.00	1.00
Visited public care facility (reference group)		(0.95, 1.05)
	1.00	1.08
Visited private care facility (0.90, 1.08)		(1.03, 1.14)

Here the relative excess risk was calculated from Poisson regression on reversed overall rating for the last dental visit with exponential estimates were used to calculate excess risk with RERI (relative excess risk due to interaction). Here higher IRR indicates better performance. Here RERI= 0.10 (0.01, 0.19) after controlling for parental education, equivalised income, country of birth, self-rated oral health, remoteness and states and territories. RERI >0 is indicative of effect modification.

2. Effect modification for the extent of change in the effect of public versus private care on the factor score for COPAS due to the indigenous status among children in Australia (n=18,240).

	Indigenous	Non-Indigenous
	IRR	IRR
	(95%CI)	(95%CI)
Visited public care facility (reference group)	1.00	0.98
Visited private care facility (0.84, 1.14)	0.98	1.11
		(1.02, 1.21)

Here the relative excess risk was calculated from Poisson regression. The factor scores for COPAS (that was derived using structural equation modelling that accounted for missing) were used as the outcome to calculate excess risk with RERI (relative excess risk due to interaction). Here higher IRR indicates better performance. Here RERI= 0.15 (0.01, 0.30) after controlling for parental education, equivalised income, country of birth, self-rated oral health, remoteness and states and territories. RERI >0 is indicative of effect modification.

9 Discussion

This chapter depicts a summary of the main findings in this thesis, provides the strengths and weaknesses of the findings along with an overall discussion, followed by the implications of the findings on public health and research, as well as draw conclusions from this work.

9.1 Summary of findings

This study aimed to measure the performance of oral care adequately and assess the differences across the Australian system and among those most vulnerable to inequities in oral health. To achieve this broad aim, four objectives were planned. These included a review of the validation process for patient reported outcomes, assessment of the psychometric properties of Child Oral care Performance Assessment Scale (COPAS), quantification of variations between states and territories in the performance of oral care delivery for children in Australia, and the difference in private versus public dental care among Indigenous and non-Indigenous children.

The critical review of patient satisfaction surveys identified a lack of instruments that were created to measure the performance of oral care for children, as well as the need for greater content validity and more accurate assessment of psychometric properties. The psychometric properties of COPAS suggested that the factor structure of COPAS was similar to the hypothesised dimensions, and there was adequate internal consistency and convergent validity for both the scale and the dimensions. Thus, it may be appropriate for the measurement of the performance of oral care among children. Following this, it was determined that the smaller states

with greater school dental service had higher performance of oral care than other jurisdictions. Finally, it was found that Indigenous children experienced lower performance in oral care from private facilities than non-Indigenous children.

9.2 Strengths

This study had several notable strengths. The dataset that was used in this study came from the National Child Oral Health Study (NCOHS 2012-2014), which is the most extensive study of its kind that assessed child oral health from a representative population. NCOHS collected oral health status data of children aged 5-14 years and their parental report of oral health-related factors. The intricate sampling techniques allowed for representative quantification of the performance of oral care for overall Australia and the states and territories separately (Do and Spencer 2016). The study also benefitted from the conceptualization and development of the items for COPAS by Do and Spencer based on National Health Performance Framework (NHPF) (NHPC 2001). The development of COPAS in-turn benefitted from the timely availability of NHPF, that provided a review of the various dimensions used for the assessment of the performance of care among several contemporary nations, as well as a framework of dimensions for the construction of indicators for the measurement of the performance of health care in Australia (NHPC 2001). This instrument along with its application in NCOHS allowed for the quantification of the performance of oral care that were the primary outcomes for this study.

This study also developed a theoretical framework to further the conceptualization and application of the performance of oral care and applied relevant advanced analytics to accomplish its aims. These frameworks included the

theorization of conceptual space for the performance of oral care versus other common healthcare outcomes and directed acyclic graphs (DAGs) for the empirical studies for assessment of their outcomes. The analytical techniques that were used here included the application of structural equation modelling and an assessment of the similarity in factor loading across five validation groups (invariance). This cross-validation was possible due to the large sample-size available for the analyses and it assessed the stability of the model across the five groups that were selected randomly for cross-validation. Appropriate analytical techniques were also used for the effect of structural variables on COPAS, including mixed effects models for the assessment of the effect of state and territories on COPAS. Here, the variable entered in to the model was the geographic location of residence and this variable was not then taken to represent the dental care system alone. By avoiding this assumption, the variable for residence was taken as such. The interpretation of the results and the possible future interventions are simplified by avoiding further assumptions. This thesis also used sophisticated methods (VanderWeele and Knol 2014) for the conceptualization and assessment of effect modification due to indigenous status on the effect of private versus public on COPAS scores. These analyses avoided the counterfactuals where ethnicity would be the exposure. Such an exposure would be illogical, and interventions based on changing ethnicity would be irrelevant (Baker and Gibson 2014).

To the best of my knowledge, this was the first study to assess the performance of oral care for children reported by their parents in a representative sample of children. This assessment used an instrument with theoretical underpinnings of an appropriate framework and related psychometric testing. The study also used appropriate analytics to quantify the effects of inter-jurisdictional

variations and a possible mechanism for the oral health inequities faced by Indigenous children in Australia.

9.3 Limitations

This study had several limitations that should be considered while interpreting the results. Our critical review suggests that there was limited theoretical and psychometric work that was carried out in the past and these limitations follow through to the modelling of the performance of oral care in general and more specifically for children. This, in turn, affected the ability to inform the current study's use of the analytical framework in the form of both the assessment of psychometric properties and the construction of DAGs for the assessment of the effect of various factors on COPAS. There is also the need for further assessment of psychometric properties of COPAS to ascertain its minimally important difference and responsiveness. These psychometric assessments are more nebulous, due to the limited theoretical work that was published in previous studies. Thus, with further development of theory and causal models, these results should be revisited and assessed for its robustness to possible changes. The information available to the DAGs were also affected by the cross-sectional nature of the NCOHS dataset. But the variables chosen for the causal effect such as the state or territory that the participants lived in, ethnicity, indicators of socioeconomic position were possibly robust to the assumption of temporality that were made for these analyses. Nonetheless, it is an important limitation of this study.

The large sample size allows for detection of statistically significant differences that can be clinically irrelevant to interpretations at an individual level. However,

smaller differences applied to larger groups still require attention, as is the case with some major dental diseases (Marcenes et al. 2013).

It is also important to note that in the estimation of effect modification for visiting private or public care facilities on COPAS by Indigenous status, there was a much smaller number of Indigenous children versus non-Indigenous children. This widened the confidence intervals for some of the stratified estimates for the Indigenous children. Despite this, effect modification was found in all the relevant analyses. Apart from the significance of the estimated differences, statistical models in this study were created for the context of each analysis. So, care should be taken while applying these results in dissimilar contexts where other confounding variables may affect the effects measured there.

9.4 General discussion

This study provided the psychometric properties of COPAS and a review of the other instruments that are currently available for the measurement of the performance of oral care using patient satisfaction. The critical review of previously published patient satisfaction questionnaires for oral health identified 14 instruments with various extents of psychometric validation (Chaffin et al. 2007; Chapko et al. 1985; Corah et al. 1984; Davies and Ware 1981; Hengst and Roghmann 1978; Imanaka et al. 2007; Koslowsky et al. 1974; Murray and Wiese 1975; Perera and Usgodaarachchi 2009; Reifel et al. 1997; Shrestha et al. 2008; Stahlacke 2007; Stewart and Spencer 1995; 1996). In all instances, the items were initially developed from an expert perspective, and there was limited testing of psychometric properties and the dimensionality of the instruments beyond that developed from exploratory factor analyses. Though there were suggestions that it might be beneficial to use

subscales consisting of the domains (Ware et al. 1983), none of the instruments reported the psychometric properties of the subscales. None of the instruments were created to measure the performance of groups outside of adult populations.

Previously, adaptations of the Dental Satisfaction Questionnaire (DSQ) were used to measure patient satisfaction among children (Brennan et al. 2001; Tellez and Kaur 2013). While 16 items of the DSQ were adapted from 43 items of an instrument that measured patient satisfaction with medical care (Davies and Ware 1982). Three additional items were added that measured pain related concepts. The items in DSQ measured access, availability/ convenience, cost, pain management, quality and an unhypothesised dimension. Both the DSQ and its adaptations that measured patient satisfaction with child oral care were not tested for adequacy of dimensionality and reported limited psychometric testing. COPAS attempted to overcome some of these known issues by creating items using the dimensions proposed by the National Health Performance Committee (NHPC 2001), and by assessing further psychometric properties that assess the extent of adherence to this conceptual framework. This assessment found that all the subscales of COPAS had adequate internal consistency and the factor structure confirmed the theoretical framework from NHPC. The psychometric testing suggested that COPAS has the potential for the evaluation of the performance of different dental healthcare systems for children.

Interstate comparisons of COPAS found that South Australia and Tasmania had better scores than other jurisdictions. In comparison, Queensland generally had the lowest scores. These findings were supported by the overall ratings for the last dental visit. One of the noteworthy differences in the oral care services among the states and territories is the extent of provision of public dental care either through the

SDS or CDS, and their criteria for eligibility and the co-payments that are applied (Do and Spencer 2016). Interstate differences in the distribution of publicly funded facilities that are available to children have led to a variety of mixed systems that have various extents of school dental systems, other publicly funded facilities that cater to children along with privately funded facilities (AIHW 2016; NACDH 2012b). This has led to a variety of mixed systems that have various extents of school dental systems, other publicly funded facilities that cater to children along with privately funded facilities. While assessing interstate differences in the performance of oral care, mixed effects models were used with sampling weights, but without adjustment of the various mediators that can attenuate the value of the interstate variations on COPAS. This was similar to another study that used a similar strategy for the assessment of the effect of oral care systems in four countries (Sanders et al. 2009). One difference in the analytical approach taken in this study was to avoid assuming that place of residence as the exposure is exchangeable with the oral care system for that region. By avoiding that assumption, this study looked instead at how appropriate the care provision was to the needs of people living in that region. The results suggested that the performance of oral care was the highest for smaller states (Tasmania and South Australia) with more universally available school dental services (NACDH 2012b). Thus, these jurisdictions have oral care systems that are better adapted to the needs of the populations under their care.

Though the perspective taken in this study was important as a starting point for assessing the effect of living in a state or territory on the performance of oral care in Australia, understanding the mechanisms that drive it would be equally important to build policy interventions to tackle the differences across these regions and further improve the performance of oral care.

Since there are interstate difference in the distribution of various dental care facilities (NACDH 2012b), it was pertinent to quantify the effect of public versus private care on the performance of oral care, since mixed systems with both public and private care may varying degrees of performance (Gibson 1998). Such a quantification needed to account for the differences that can be perceived by the Indigenous children and non-Indigenous children. The differences in outcomes based on the Indigenous status was expected due to the significantly higher disease burden with about 60% higher proportion of children who were 6-8 years of age with caries experience and a greater experience of caries than the national average (mean DMFT of 3.4 vs 2.0) (Jamieson et al. 2010), making it pertinent to quantify the effect of public versus private care on the performance of oral care. It was also noted that the dental visitation was lower among the children who experienced greater discrimination (Jamieson et al. 2013). The current study found that in stratified analyses, there was an increase in the performance of oral care among the non-Indigenous children who visited private dental facilities versus public care facilities. This increase in performance was not present among the Indigenous children in Australia. The measurement of effect modification on additive and multiplicative scale using linear and dichotomous scales had the same findings. This difference was also present when analysed using overall rating for last dental visit and using factor scores for COPAS.

The use of DAGs enabled the models to adjust for confounding variables that included socioeconomic position, remoteness, oral health status, and states and territories. Socioeconomic position was assessed using education, equivalised income (ABS 2016) and parent country of birth. This analytical planning helped avoid adjusting for mediating variables that could have attenuated the total effect. The

stratified mixed effects models that adjusted for the confounding variables reported central estimates for the Indigenous group that were more likely to favour public care (though with wide confidence intervals). This, along with the consistency of the results in the regression estimates for additive and multiplicative effects for the continuous outcome and the RERI from dichotomised outcome lends credence to the modification of effect reported.

This may explain one of the mechanisms that result in the higher disease experience among Indigenous children (Do and Spencer 2016; Jamieson et al. 2010). The study suggests that an increase in the provision of care from private facilities may increase oral health inequities that further marginalise Indigenous Australians. Such a differential effect also alludes to structural racism (Powell 2007), where often colour-blind policies without an explicit intent of discrimination can persecute minority communities (Bailey et al. 2017; Gee and Ford 2011). Similar to the findings of a current systematic review (Basu et al. 2012), findings of this study also confirm that private care is not always more effective or efficient than public care.

It is also important to concede that the definition of health, healthcare and performance of healthcare operationalised in this paper were not adapted to the values held by the diverse Indigenous communities in Australia. Such an adaptation was recommended (Department of Health 2013) and should be a future goal for a more appropriate measurement of health states, care provision and its performance. Despite this, the assessments of effect modification show a significant difference in the effect of visiting a private facility when compared to public facilities on the performance of oral care was indeed modified by the Indigenous status.

Thus, this study found interstate differences in the performance of oral care and differences in the performance of private care versus public care based on Indigenous status. These findings warrant further examination for the mechanisms that enable them and possibly ways to minimise the interstate variations as well as inequities in the performance of oral care for children.

9.5 Study implications

9.5.1 Implications for research

The review of literature for this study and other readings suggest that there is a lack of well-defined theoretical frameworks and psychometric assessments applied to the measurement of oral health performance. This is especially true of the measurement of the performance of oral care for children. This study extends the previous work in this area by quantifying psychometric properties of COPAS while maintaining its theorised dimensionality under NHPF (NHPC 2001). There is a need for future studies to further assess the psychometric properties of this new scale with a measurement of its responsiveness and minimally important differences for various scenarios.

With a relative lack of work related to measurement properties in this area comes a relative lack of causal modelling of the performance of oral care, especially that related to children. The information needed for causal modelling and the construction of DAGs are limited due to the limitations in previous work. The current thesis provides some initial DAGs for modelling the performance of oral care. In future, such DAGs will benefit from more information for various research questions and scenarios.

This study quantified a causal pathway for the inequity that is faced by Indigenous Australians. This went beyond the assertion that there is inequity and looked for one of the present pathways in this scenario. However, it was also noted that the definition of health and the performance of care could be improved, so that various perspectives of the Aboriginal and Torres Straits Islander communities are included in this measurement (Department of Health 2013). Thus, future research could improve on the current study by applying more appropriate definitions and measures, while assessing the inequities faced by the Indigenous populations.

9.5.2 Implications for public health

This thesis found that COPAS provides an instrument to measure the performance of oral care for children, with adequate psychometric properties. Such a measure can enable the surveillance of the performance of oral care and also assess the impact of various policy measures aiming at the performance of oral care for children.

It was also found for the first time that there are differences in the performance of oral care for children among the various states and territories in Australia. The analyses took the perspective of assessing the appropriateness of the dental care system for the population under its care, by avoiding the control of mediators that could change the interpretation of the results. This provides the states and territories with a means for comparatively visualising the appropriateness of their dental care systems. To this end, the changes needed in the states and territories need to be tailored to their individual needs. There is also a need to further scrutinize the specific shortfalls in meeting the expectations and needs of the populations under their care.

Public care provision mostly comes under the preview of the state. From a public health perspective, the results suggest that public care provision is equivalent to private care provision in its effectiveness and efficiency. However, there are shortfalls in other areas such as continuity of care. Thus, creation of policies that aim to improve the performance of oral care in the dimensions that were lower in public care could help it achieve the equivalency with private care facilities.

Since it is known that the Indigenous children face a higher burden of disease, a pathway that can perpetuate such inequities was quantified in this study. It would be essential to address this pathway and assess other pathways that enable inequity in oral care among a group that faces a higher burden of disease. Two lines of actions could be taken to reduce the inequities faced by Indigenous Australians. 1. Identify and address the reasons that public care facilities fall short of private care facilities in the performance of oral care. 2. Reduce the need for visiting private locations for publicly funded courses of treatment. Actions taken on both of these could synergistically help reduce the inequity in performance of oral care that is faced by Indigenous Australian children.

9.6 Conclusions

This thesis examined the measurement properties of COPAS while developing a conceptualisation of the performance of oral care for the common oral health outcomes. It also quantified the performance of oral care for common variations in the oral care system in Australia. These included the variations in oral care system between the states and territories, as well as the effect of visiting public versus private care on the performance of oral care and the heterogeneity of this effect

based on the Indigenous status of children. The specific conclusions of the thesis were:

1. The critical review of patient satisfaction questionnaires found that there was a lack of instruments with adequate measurement properties, as well as a theoretical background that assessed the performance of oral care from the perspective of the care receivers. This was especially true for children, and other populations outside of general adult populations.
2. Assessment of the psychometric properties of COPAS and COPAS-Partial found that it had adequate psychometric properties for its use in measuring the performance of oral care among children. These measurement properties included acceptable structural validity, construct validity and internal consistency in the models tested for COPAS and COPAS-Partial.
3. Assessment of the effect of living in a state or territory in Australia found that smaller states with predominant school dental services, namely Tasmania and South Australia, had a higher performance of oral care than the other states and territories.
4. Private dental care had higher COPAS scores than public care among non-Indigenous children, while they were similar for Indigenous children. Effect modification of the effect of public versus private care on the performance of oral care due to Indigenous status found a higher performance of oral care in private care locations among non-Indigenous children versus Indigenous children.

9.7 References

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