Medical student selection criteria and their influence on demographic characteristics and academic outcomes in a new graduate entry medical programme at The University of Western Australia

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I, Andrew Lim, certify that:

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Technical assistance was kindly provided by Mr Marty Firth from the School of Mathematics and Statistics, UWA for statistical advice that is described in Chapter 3, Research Methodology.

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Abstract

The aim of selection processes of students into a medical degree is to identify those who are likely to perform well academically during the course, in addition to becoming proficient medical practitioners. In recent years, there has been growth in the number of graduate entry medical programmes in Australia. This shift has altered not only the selection processes, but also the academic and socio-economic diversity of the medical student population. Selection criteria and their predictive validity for performance on the medical course are subject to much recent research and debate in the literature.

In 2014, the University of Western Australia (UWA) replaced the existing six-year undergraduate Bachelor of Medicine/Bachelor of Surgery degree (MBBS) with a four-year full-time graduate-entry Doctor of Medicine (MD). Appropriate candidates are selected for acceptance into the UWA MD programme utilising measures of prior academic achievement (Grade Point Average, GPA), aptitude testing (Graduate Australian Medical Schools Admissions Test, GAMSAT) and a structured interview.

The primary aim of the research was to examine the relationship between the students’ pathway of entry, performance in selection criteria, socioeconomic background, demographic characteristics and their academic outcomes in the first two academic years of the initial cohort of students enrolled in the new UWA MD program.
Demographic, admission and assessment data were collected on 208 students entering the first year of the UWA MD degree. Demographic and admission data included the following variables; age, gender, state of application, Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) scores, GAMSAT scores, previous bachelor degree, prior academic performance and interview scores. Outcome measures included assessments scores for assignments, and an overall final weighted grade for each unit. Univariate analysis utilising Pearson correlation coefficients were calculated for each of the predictor variables of entry scores, age, gender, discipline of first degree, rurality and socioeconomic status. Linear regression models were constructed for each outcome variable using the full set of predictor variables. Additionally, regression analysis was undertaken with the entry scores as outcome variables. ANOVA with Bonferroni correction were performed when analysing the pathways of entry into the degree.

The results of the study demonstrated that prior academic performance and GAMSAT section 3 were the most consistent predictors of academic performance in the first three units of the course, whilst a humanities background predicted a poorer performance in most of the final unit scores. Older age at entry predicted poorer performance in the first year. Students from a health science background and older age at entry demonstrated a better overall performance in the interview. Male students performed better in the GAMSAT overall score. Weaker performance across all three selection criteria was strongly correlated to students of a rural background.
This study examining the new UWA MD degree, reinforces previous literature regarding the association between prior academic performance and the GAMSAT as stronger predictors for performance in-course, particularly in the initial years. Prior academic background in the humanities/law/commerce/business appears to be a disadvantage in terms of performance in the early years of the course. This study has also confirmed previous findings of gender bias with higher GAMSAT scores by males.
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1. Introduction

1.1 Introduction

The following chapter provides an introduction to the history of graduate entry medicine in Australia, the admission process and the local background of which this research is based. Firstly, a summary will be provided of the history of medical schools within Australia and their admission processes. This will be followed by an introduction to the UWA MD course, its selection criteria and curriculum. Lastly, the final part of the introduction will define the purpose, aims, research questions and significance of undertaking this study.

1.2 Graduate entry Medicine

The rationale for graduate entry programs has been subject to debate in prior literature. As early as 1991, Geffen⁴ raised the argument that the development of four-year graduate medical schools would ‘…permit a greater degree of self-selection of motivated students able to perform well in tertiary studies’. His reasoning for this included: the elimination of forced career choice decisions with no personal experiences to guide them, a longer maturation process that allows for motivation to express itself, and a ‘levelling of the playing field’ so students from disadvantaged backgrounds can demonstrate their potential. It was also argued that traditionally, in the United States and Canada, an appropriate college degree was
generally required prior to admission into a medical course of four years’ duration. An editorial in 2003 by Miflin et al \(^2\) re-iterated the arguments for the change from school-leaver entry to graduate entry, with the benefit of six-years of experience with the graduate-entry program at the University of Queensland from its inception in 1997. The perceived advantages of the graduate entry program included: the elimination of premature decision making for medical studies, greater maturity in the student body, and levelling of the playing field, i.e. so that students from disadvantaged backgrounds, or non-secondary school science backgrounds would be able to demonstrate their ability to achieve at university level. As part of their experience, the authors highlighted that long-serving problem-based learning (PBL) tutors reported students engaged in a more mature approach to problem discussion, demonstrated greater commitment in study, and were more self-sufficient in general.

Graduate entry medicine is a more recent development within medical schools in Australia, and the Commonwealth nations. Traditionally, medical schools have admitted students directly from their secondary education, i.e. school-leaver entry. However concurrent to this, a significant change occurred in medical education with a greater emphasis on learner-centred and problem oriented approaches to teaching \(^3\). The idea of this shift in pedagogy in the medical curriculum was to promote self-directed learning, and in doing so, produce doctors equipped for continued learning and able to meet the changing expectations of patients \(^4\). As a result of these changes, most medical schools altered their selection procedures to enrol students more likely to perform well in the new curricula \(^5\).
In Australia, the first medical school to establish a graduate entry medical course was Flinders University, with their first cohort enrolled in 1996. Since this time, there has been a steady increase in the number of universities introducing graduate entry medical courses, many of which have replaced previous undergraduate degrees. With the shift in entry criteria, there was a concurrent change in the medical curriculum. As such, the inclusion of problem-based learning and early clinical contact with the development of clinical skills was introduced. Other core components of the curriculum included coverage of personal and professional development, and the sociocultural aspects of medicine. These features were facilitated by innovative methods of teaching, and flexible delivery of course content.

Most graduate-entry medical degrees are of four years’ duration, with the focus on basic sciences and research training in the first two years. The latter two years generally involve the integration of basic sciences into the clinical context, facilitated by clinical rotations in a practical setting. Traditionally, medical schools in Australia awarded graduates a Bachelor of Medicine Bachelor of Surgery (MBBS). In 2011, with a change in the Australian Qualifications Framework (AQF), most universities opted to transition their courses to a newer category, level 9 Master’s extended degree, which allowed for the use of ‘Doctor’ in the degree title, i.e. Doctor of Medicine (MD).
1.3 Selection Processes for Australian Medical Schools

It is recognised that the aim of selection processes of students into a medical degree is to identify those who are likely to perform well academically during the course, in addition to becoming proficient medical practitioners of the future. Entrance into a medical degree is a highly competitive process, due to an ongoing demand for limited course places. As mentioned previously, in recent years there has been a significant growth in the number of graduate entry medical programmes in Australia. This shift, from undergraduate to postgraduate degrees has altered not only the selection processes, but also the academic and socio-economic diversity of the medical student population.

There are currently 18 medical schools within Australia, and a combination of selection tools and procedures are utilised by the universities to select appropriate candidates for acceptance into medical courses. In general terms, these include measures of prior academic achievement (school results or undergraduate degree), aptitude testing and interviews. For graduate entry programmes, prior academic achievement is based on the Grade Point Average (GPA) during their undergraduate degree. These selection criteria and their predictive validity for performance on the medical course are subject to much recent research and debate in the literature. Due to outcomes of prior research, the University of Queensland do not conduct interviews as part of their selection process.

The Graduate Entry Medical School Admission System (GEMSAS) is an on-line application and matching system for applicants for most Australian graduate-entry
medical schools. GEMSAS manages applications from prospective students by calculating grade-point averages from their previous academic studies, and allocates an applicant an offer of an interview at their highest preferred medical school for which he or she is eligible.

1.4 UWA Doctor of Medicine (MD) Course

1.4.1 Background

The University of Western Australia (UWA) embarked upon a restructure of all coursework degrees, which involved rationalisation of undergraduate degrees and transition to postgraduate professional qualifications. In doing so, the Faculty of Medicine, Dentistry and Health sciences at UWA, re-developed their curricula and degrees to reflect this change. The previous medical course, a Bachelor of Medicine/Bachelor of Surgery degree (MBBS), consisted of both a 6-year undergraduate intake, and a 4-year graduate entry intake. Students in the latter cohort had undertaken a 6-month bridging course to transition to levels 3 to 6 of the undergraduate degree. Following the university restructure, a four-year full-time graduate-entry Doctor of Medicine (MD) course was developed. The inaugural intake of students commenced their first year of study in the MD in 2014.

1.4.2 Selection pathways

There are two main pathways of selection into the MD course at UWA. This includes both a school-leaver (assured entry) and a graduate-entry cohort. Within
each of these are a rural entry pathway and a special access pathway, known as the Broadway pathway. The school-leaver pathways (or assured entry) account for approximately one-third of the total intake. Selection through this pathway requires high academic achievement with a minimum Australian Tertiary Admission Rank (ATAR) of 99\textsuperscript{14}, or 96 for the rural and Broadway pathways, in addition to a suitable Undergraduate Medicine and Health Sciences Admission Test (UMAT)\textsuperscript{15} and interview score. Final ranking is based on a 40:20:40 weighting of these three components, respectively. Successful candidates will undertake an undergraduate bachelor degree at UWA and are subsequently required to maintain a high academic standard (GPA>5.5) across the degree to proceed to the MD course.

For selection via the graduate-entry pathway, candidates require a previous bachelor degree (or equivalent) and a minimum GPA of 5.5 from the most recent three years of their coursework study. These students are required to undertake the Graduate Australian Medical Schools Admissions Test (GAMSAT) and are selected for the structured interview based on a combined score of both their GPA and GAMSAT, with equivalent weighting of the two components. Final ranking for an offer of a place is based equally on all three selection components (GPA, GAMSAT score and interview score).
The interview at UWA is a highly structured, panel-based interview assessing six criteria, in addition to communication skills. The structure of this interview has been outlined in detail in a prior paper (see, 8.1 Appendix A- Structured Interview) 16.

In Australia, the GAMSAT is the most commonly employed method of cognitive aptitude testing, for those candidates applying to enter a graduate entry medical course 17. The GAMSAT has been used since 1996 in Australian medical schools, and is considered an objective measure of the applicants’ capability for medical study. The equivalent assessment for undergraduate students is the UMAT 15. In the majority of Australian universities, performance in these tests often determines a candidate’s progression to an interview. The GAMSAT consists of three sections; Reasoning in the humanities and social sciences (Section 1), Written communication (Section 2), and Reasoning in the biological and physical sciences (Section 3). Section 3 is double weighted for all the participating universities in Australia, except
one. Both the UMAT and GAMSAT examine attributes such as critical thinking and problem solving, in addition to other cognitive characteristics. While these attributes are considered important in the development of students and their future medical practice, the predictive validity of these tests remains unclear.

For school-leavers at UWA, a special access pathway (Broadway) and separate Rural-entry pathway exist to promote student diversity amongst the cohort. For school-leavers to be eligible for entry via the Broadway pathway, the prerequisite is that they have graduated from a Western Australian school of relative social disadvantage- based on an Index of Community Socio-educational Advantage (ICSEA) score. The eligible schools are designated Broadway schools as part of a broader UWA program and some of these students receive an adjustment to their ATAR score, based on their level of educational disadvantage. Eligibility for the rural pathway was based on the candidate residing in an Australian Standard Geographical Classification - Remoteness Area (ASGC-RA) categories 2-5 for a minimum period of five years from commencement of primary school. The ATAR ranking to meet eligibility via this entry pathway is 96, which is slightly lower than for the standard-entry applicants. The UMAT and interview are still essential requirements. Ranking for Broadway-entry is weighted similarly to the standard-entry candidates. The Rural-entry candidate’s rank is weighted 30:30:15:25, based on ATAR, interview, UMAT and rurality score, respectively. The first cohort of school-leavers was selected to start their undergraduate studies in 2012, so they have entered the MD in 2015. As this study explored the first cohort of MD students, this initial school-leaver cohort was not captured in the data presented. However, each cohort has a Broadway and a Rural sub-quota as defined above. In the case of the
2014 cohort these sub-quotas were selected from graduate applicants who fulfilled the requirements.

### 1.4.3 Curriculum

The MD course at UWA is delivered as an Extended Masters’ program (level 9) in the Australian Qualities Framework. The total academic period is 168 weeks, divided into 42 teaching weeks per year.

The curriculum is divided into four phases:

- **Phase 1:** Foundations of Medical Practice (1 semester)
- **Phase 2:** Systems-based Learning and Practice (2 semesters)
- **Phase 3:** Clinical Learning and Practice (3 semesters)
- **Phase 4:** Transition to Postgraduate Practice (2 semesters).

Students entering the course have broad, undifferentiated academic backgrounds, and therefore within Phase 1 are introduced to basic, applied and clinical sciences that inform modern-day medical practice. ‘Foundations of Medical Practice’ is the initial unit undertaken by students in the MD course and occurs over one semester. The aim of this unit is to cover basic concepts of anatomy, biochemistry, physiology, genetics, pathology, infectious disease and pharmacology. In addition to the biomedical sciences, students are also introduced to professional aspects of medicine, epidemiology, medical research, evidenced based medicine and the social determinants of health. Students undertake training in history taking as part of the medical consultation, with the aim of developing communication skills. The unit also
explores the impact of historical and socio-cultural factors on Aboriginal and Torres Strait Islander peoples’ health and healthcare.

‘Foundations of medical practice’ utilises a variety of educational styles and methods to facilitate learning. These include:

- Large group learning delivered via lectures,
- Small group learning and lab sessions,
- Case-enhanced learning (CEL),
- Clinical skills sessions,
- Laboratory and Pathology tutorial sessions,
- Multidisciplinary seminars, and
- Clinical/Community placements.

Much of the focus of this learning structure is to provide students the opportunity to work with each other collaboratively, and integrate knowledge of the biomedical sciences with illustration by realistic clinical cases.

In Phase 2, the curriculum is structured to allow students to utilise their acquired knowledge to each organ/system of the body, and to have had a broad exposure to different types of clinical environments. The unit for Phase 2 is termed ‘Systems-based Learning’ and teaching is facilitated similarly to Phase 1. Phase 2 consists of two units, Systems-based Learning 1 and 2.

Phase 3 incorporates the clinical aspects of medicine with increased exposure to clinical settings in the fields of surgery, psychiatry, internal medicine and
geriatrics/rheumatology. A longitudinal general practice attachment also occurs during this phase. The first unit of Phase 3 is Integrated Medical Practice 1

1.4.4 Assessment

The assessment methods for the course are varied and comprise both formative and summative components. The purpose of the formative assessment is to provide regular, constructive feedback to students in order to improve their summative assessment outcomes. Formative assessment feedback is provided through self-assessment, peer assessment, and tutor feedback. The summative assessment in phase 1 contributes to the final mark for the unit, and is centred on three main components:

- Professional behaviour and attendance
- Examinations
- Assignments

Professional behaviour and attendance is graded as acceptable or not acceptable, and is based on their attendance at small groups teaching sessions. This is also applicable to the assessment in phase 2.

The examinations are made up of both written and practical components. There are five written examinations which are predominantly assessing the student’s knowledge, each worth 10% of the final unit mark. In addition, an objective structured practical examination (OSPE) assesses the practical components of the learning sessions, which contributes a further 10% to the final grade.
There are four written assignments, assessing various domains and skills, each contributing 10% to the final unit grade.

These assignments are as follows;

- The Global Health and Social Justice assignment is a group project examining a topic in the area of global health, or social justice/health disparities issue. One of the main skills assessed is the students’ ability to critically analyse literature.

- The Aboriginal Health assignment is an individual project that demonstrates both the students’ attitudes and understanding of issues influencing health in the Aboriginal population.

- The Review Paper is an overview of a health topic of significance, which will assess critical analysis of the literature.

- The Clinical placement report is an assignment based on the students’ experience on their clinical placement, in particular their communication and interactions with patients, and health professionals.

Similar to the phase 1 summative assessments, the phase 2 assessments also contribute to the students’ final grade for the course and consist of three main components:\n
- Professional behaviour and attendance

- Examinations

- Assignments
The examination structure is similar to Phase 1, however there is one less in-semester examination, resulting in a total of 5 exams worth 10% each. In the first unit of phase 2, there are five written assignments, each contributing 10% to the final unit mark. These assignments are;

- Health care systems assignment- a critical analysis assessment of the care of patients with mental health issues at the local, regional and national level.
- Aboriginal health assignment- a reflective written component that demonstrates students’ understanding of issues influencing the Aboriginal population.
- Critical appraisal report- a critical analysis of the medical literature regarding a single medical topic as part of evidenced based medicine.
- Cased-enhanced learning (CEL) facilitation assignment- comprises both group and individual components. Each student facilitates a learning activity, which incorporates their skills of effective communication and teaching in small groups.
- Preventative medicine program report- involves designing a preventative medicine program for one of the leading causes of disease burden in Australia.

The second unit of phase 2 consists of three written examinations worth a total of 50% of the final mark, one structured clinical assessment contributing 10% of the final mark, an OPSE worth 15% and three assignments contributing 25% to the final mark. The three assignments are;

- Research and Biostatistics Part 1- an individual assignment comprising exercises and questions relating to the statistical software IBM SPSS ©.
- Research and Biostatistics Part 2- an assignment undertaken in pairs, involving submission of a research proposal report.
- Ethics and Advocacy in Medicine Essay- an essay examining the ethical and/or advocacy issues relating to a clinical case or scenario.

The Integrated Medical Practice Unit 1 is the initial unit of phase 3 of the UWA MD degree. The unit assessment structure includes two end of year assessments, comprising a written examination and an objective structured clinical examination. These examinations make up 60% of the total mark of the unit. The remaining 40% of the final mark consists of in-training assessments in each of the components of the unit, i.e. general practice, geriatric medicine, rheumatology, general surgery, psychiatry and internal medicine. The majority of the in-training assessments are either observed case presentations or clinical assessments.

The remaining units of the course will not be discussed further, as they do not pertain to the current study.

1.5 The Current Study

1.5.1 Purpose, Aims and Questions

It remains unclear how students from each of the three pathways (Standard, Rural and Broadway) will perform in the new UWA MD course. Similarly, the relationship between entry factors and academic performance in this specific graduate-entry
The cohort has not previously been examined. Information obtained from the study will also seek to explore the relationship between these predictive background factors and outcomes for specific assessments within the course, an area which appears under-researched in the literature. The results of this research may add to the growing body of predictive validity studies, with respect to entry scores and academic performance during medical courses in general.

The primary aim of this research is to examine the relationship between the students’ pathway of entry, performance in selection criteria, socioeconomic background, demographic characteristics and their academic outcomes in the first two academic years of the UWA MD program.

The following research questions will be addressed:

- What is the relationship between the UWA MD course selection criteria (GPA, Interview score, GAMSAT scores) and the demographic profile of students?

- What is the relationship between the background demographic characteristics of students enrolled in the UWA MD course and their academic outcomes at the end of the first two years of their degree?

- What is the relationship between the background demographic characteristics of students enrolled in the UWA MD course and their academic outcomes, specifically assignments within the course?
- What is the relationship between the pathway of entry (Standard, Rural and Broadway) to the UWA MD course and subsequent academic performance?

1.5.2 Significance of this Research

As discussed in a prior section, the UWA MD is a new degree and differs to the previously delivered medical courses at the university. The curriculum has been altered to reflect the Extended Masters’ Framework as part of the AQF 7. There is therefore a need to explore the associations between predictive elements and performance in this new degree. This will be the first analysis of these factors and outcomes for the UWA MD degree.

By providing a greater insight into student performance, this will have possible implications regarding the selection processes into the medical degree. Similarly, identifying the impact of these selection processes and the potential effects in the diversity and demographic profile of the cohort may provide justification for broadening (or adjusting) special-entry quotas of students. These adjustments may aid to serve the requirements of the wider community.

On a larger scale, the implications of this research may also identify the background characteristics of students and their academic performance in specific assessments within medical courses. Identifying this relationship has the potential to influence assessment structure and the curriculum, especially if a particular bias is identified.
2. Literature Review

2.1 Introduction

The previous chapter outlined the rationale behind graduate entry medical programmes and the various selection tools that are currently utilised to select students to a graduate entry medical degree. It also provided context to the current study by exploring the UWA MD programme, including its selection pathways, curriculum and assessments.

Chapter 2 begins by exploring prior research examining the predictive validity of each of the selection criteria, and their utility in identifying those students most likely to perform during the course and beyond. This is followed by an examination of prior studies exploring the use of selection criteria and alterations of the demographic composition of the student population within a medical course. Lastly, Chapter 2 also explores previous literature relating to the demographic background of students and its effect on their academic outcomes in a medical degree.

2.2 Predictive Validity of the Selection Processes

The aim of the selection process is to identify those students who are more likely to succeed during the course and beyond, as medical practitioners of the future. The widespread introduction of graduate-entry medicine programs in recent years has
altered these selection processes, and in doing so has diversified the socioeconomic and academic backgrounds of the medical student population \(^8,9\).

In order to review the literature, a search of the medical database MEDLINE ® was undertaken utilising key search terms “predictive validity”, “medical student” and “selection criteria”. Additional search terms were also utilised for the specific selection criteria, i.e. interviews, cognitive testing and prior academic achievement. Each article was reviewed for relevance to the current study, particularly with respect to the specific selection tools, and overall applicability to the local context.

2.2.1 Cognitive and Aptitude testing

Previous studies examining the predictive validity of the GAMSAT have demonstrated mixed outcomes. Groves et al \(^{24}\) described a weak association between the GAMSAT and second year examination results based on a voluntary cohort of 189 medical students at two Australian universities. Students at the University of Queensland and the University of Sydney were asked to undertake two validated tests of clinical reasoning, the Diagnostic Thinking Inventory (DTI) and the Clinical Reasoning Problems (CRP). The DTI is a self-report questionnaire and is a measure of reasoning, independent of knowledge, whereas the focus of the CRP is on the integration of knowledge. The results of these tests, and their Year 2 academic outcomes were correlated to their entry GAMSAT and interview scores. There was a weak negative correlation between scores for the GAMSAT and the DTI, and no correlation found with the CRP. In addition, the correlation between GAMSAT and examination results was weak (r<0.24, P=0.02). The authors suggested that the
observation of a negative correlation between the GAMSAT and the DTI, and its weak positive correlation with examination scores underpins the argument that the GAMSAT is more likely a measure of knowledge than reasoning.

A larger study by Coates \(^{25}\), demonstrated the validity of the GAMSAT and grade point average (GPA) combined on first year performance across six universities in Australia. Based on their observations, small associations were noted between interview and GAMSAT scores, indicating the GAMSAT and interviews provide independent sources of evidence regarding an applicant’s ability for medical study. Similarly, a divergent relationship was observed between GAMSAT and GPA scores, aside from a small relationship between GAMSAT Section 3, and outcomes in the earlier years. This is most likely attributed to the science backgrounds of many of the students, and predominance of biology and chemistry in the first year of medical school. Coates also noted that performance in Year 1 is best predicted by a linear combination of GPA and GAMSAT scores based on regression modelling.

A recent study of 421 graduate entrants, examined the predictors of academic outcomes in a single-institution, Australian graduate entry medical programme \(^{26}\). Regression models were based on variables of entry scores (including the 3 sections and total of the GAMSAT), demographic backgrounds and outcome measures. With regard to the predictive validity of the GAMSAT, similar to the previously described study, section 3 was the most consistent GAMSAT section in predicting academic performance. This relationship was observed more strongly earlier in the course, in keeping with the science-oriented focus of the earlier years. Further findings from this study will be highlighted in the ensuing background discussion.
Conversely, there is evidence to suggest poorer relationships between the GAMSAT and academic outcomes \(^{27,28}\). In a full set of cross-model correlations examining a graduate entry medical school at the University of Wales (UK), Bodger et al \(^{27}\) determined that the student’s previous academic record and their general exam performance was the one significant relationship between selection criteria and assessment outcomes. The authors were unable to find any strong associations between the GAMSAT and the assessment outcomes. It was also recognised by the authors, that the presumed skills required to perform well in both case study and OSCE assessments did not correlate to the GAMSAT. This was noted to be an interesting finding given that the skills tested include aptitude, reasoning and communication.

### 2.2.2 Interviews

The rationale behind the use of interviews as a selection criterion into a medical degree is to assess the non-academic qualities and attributes of candidates. Most universities in Australia originally conducted panel-based interviews consisting of up to three interviewers, with questioning and discussion of each potential candidate. Each university now has its own interview procedure and structure. In recent years, there has been an increasing shift from panel-based interviews to multiple mini interviews due to possible concerns regarding reliability and interviewer bias \(^{29,30}\). In general, due to their inherently subjective nature, controversy remains surrounding the utility and predictive validity of interviews in medical student selection \(^{12,31}\).
One of the studies described in a previous section, which examined the relationship between the GAMSAT and subsequent performance in medical school based on the DTI and CRP, also investigated the relationship of a structured interview and its outcomes. The two Australian universities analysed in this study, offer semi-structured interviews designed to evaluate communication skills, cognitive style and decision-making ability, cooperativeness and participation, motivation and personal attributes. Weak associations were noted between the GAMSAT and interview, which was thought to exist due to their assessment of differing constructs. There was no observed relationship between interview scores and academic achievement or the measures of clinical reasoning. However, a study in 2003 by the same author examined three successive student year cohorts, comprising 290 students at the University of Queensland. They determined a small but significant relationship between the pre-admission interview score and the DTI, highlighting the purpose of the interview and its assessment of reasoning style and attitude rather than knowledge.

The impact of a study examining selection procedures at the University of Queensland led to a more dramatic shift in policy, by removing the interview as part of its selection process. Whilst an association was evident between interview scores and academic performance, correlations with interview scores were consistently lower than those for the GPA - except for the final year clinical examination. A larger difference was also observed for the overall examination score with the standardised coefficients of interview scores approximately three times lower than that for the GPA, i.e. 0.95 vs 3.72, both of which were statistically significant. Interestingly, a subsequent study by the same authors examining the
outcomes of removal of the interview, demonstrated a gender bias towards the selection of male students. The authors attributed this finding to higher scores achieved by male applicants in Section 3 of the GAMSAT, which was correlated to higher overall GAMSAT scores and thus improving their overall ranking for selection into the medical school.

One of the earlier studies examining the predictive validity of a structured pre-admission interview for medical student selection explored two aspects of student progress, graduation with honours and failure to complete the course. The study conducted at the University of Newcastle, matched a control group to those students who failed to complete the course. Interviewer ratings across of a variety of characteristics were significantly lower for those in the latter group, compared to the controls. In the second part of this study, the scores at interview for the students who graduated with honours were matched with a group that graduated without honours. Similar to the previous findings, across the comparisons, those who graduated with honours outperformed their matched controls.

More recent studies have also investigated the predictive validity of interviews at both the undergraduate and postgraduate level. Mercer and Puddey, reported findings from an analysis of eleven cohorts of undergraduate students between 1999 and 2009 at UWA. The standardised interview score was a strong predictor of academic outcomes in years four to six (of a six-year undergraduate degree) based on the Weighted Average Mark (WAM). One of the secondary outcomes also assessed, included the relationship between interview scores and categorisation of specific units to predominantly ‘knowledge’-based or ‘clinically’- based. Regression
modelling demonstrated greater predictive validity of the interview for ‘clinically’ based units at all levels of the course. The same authors explored this association in a cohort of graduate-entry medical students at UWA (n=421) and noted a weak association between the interview score and the clinically-based units, particularly later in the course (levels 5 and 6). Converse to these findings, a study of three Australian universities (two of which utilised interviews). Edwards (BMC 2013) identified a negative association between the interview and GPA, with the implication that poorer interview performance was associated with higher medical school GPA. As explained by the authors, this relationship was not unexpected given the predominant purpose of interviews in examining non-cognitive traits.

A more recent systematic review by Patterson et al in 2016 examined 75 studies assessing the use of interviews. The authors of this review have suggested generally poor predictive validity of traditional interviews and highlighted possible reasons for this difference. In particular, the varying interview methods between institutions, from traditional unstructured interviews to more structured panel interviews. Based on their review, it is generally accepted that more structured interviews, including multiple mini interviews (MMI), improve both reliability and predictive validity of the interview process.

### 2.2.3 Prior academic record

Prior academic record has traditionally been the primary method of selection of students into medical school, as it has been consistently observed to have the highest predictive validity in medical school. Concerns have been raised regarding its
utility in isolation, given the known influences of gender, background and socioeconomic demographics on prior academic performance.

The study at the University of Queensland previously discussed, correlated student academic performance with their baseline selection criteria. The predictive validity of both combined and individual selection criteria were analysed. When the individual selection criteria were assessed, prior academic record (measured by the GPA at entry) was independently associated with final performance in each cohort. This association was consistently significant, independent and observed across each examination, and their respective components. As part of this study, β coefficients were utilised to show the relative independent contribution of the predictor variables. The GPA β values were consistently higher than those of the interviews, indicating its relative greater importance in explaining variation in academic performance. Hence, the decision by the university to remove the interview from their selection process.

A recent study undertaken in the Netherlands examined three admissions process within the one medical school over a three-year period. A national policy exists in the Netherlands where three pathways to admission into medical school are in place. These include; achieving a high GPA (>8, on a scale to 10) to gain admission to a university of their choice without further assessment, a multi-faceted selection process consisting of knowledge and behavioural based assessment (dependent on the school), and lastly, a national weighted lottery where applicants are categorised based on their pre-university GPA. The students selected through the high pre-
university GPA pathway performed better in written test scores, obtaining course credits and professionalism, compared to the other groups.

In a study by McManus et al. [37], construct-level predictive validities were calculated to provide a better representation of true predictor-outcome correlation across the range of applicant abilities. This UK-based study examined six cohort studies of medical student selection with predictor variables including A-levels, General Certificates of Secondary Education, O-levels and aptitude testing. Meta-regression for construct-level predictive validity of A-levels, GCSEs/O-levels and Aptitude tests for Undergraduate performance was undertaken. Whilst all showed significant construct-level predictive validity, A-levels were observed to be the best predictor (.723; CI .616 to .803). Aptitude testing was the least predictive .181 (CI: .055 to .302). These findings were also observed in a similar study of a graduate program at Swansea University in the UK [27] where A-level results were seen to be the most useful in predicting the final mark. In addition to this, the authors split the data into two groups prior to applying a multivariable factor analysis, i.e. selection and assessment. The only relationship that was demonstrated to be significant was between the student’s previous academic record and their general exam performance.

A cross-institutional study of two undergraduate medical schools in New Zealand compared UMAT scores and GPA in the prediction of performance in medical school [28]. Outcomes were based on routine summative in-programme assessments and predictive validity was calculated utilising regression models. The findings from this study determined that the combination of the UMAT and admission GPA improved the predictive power across all outcomes measures at both universities.
However, GPA models were more predictive than the UMAT models for most outcome measures. The highest net predictive power of admission GPA was highest for Year 2 GPA accounting for 33.8% of the variance. In contrast, the highest predictive power of the UMAT score was 9.9% for the Year 5 written examination at the University of Auckland. This study again highlights the predictive validity of prior academic performance in medical student selection.

Prior studies have also demonstrated the greater effect of prior academic achievement earlier in the medical course, with attenuation as the course progresses. The authors of this study examined the relationship between the tertiary examination rank (TER), an aggregate rank based on final secondary school exams, and the academic year Weighted Average Mark (WAM). Eleven cohorts of students were studied, and as previously referenced, the UMAT and interview scores were also utilised as predictor variables. A stronger correlation between the TER and their WAM was noted in Years 1-3 compared to later in the course, i.e. Years 4-6. These findings were also replicated in regression models where the strongest predictors of a higher WAM in each year were TER and female sex (p<0.001). The effect of the TER diminished from Year 1 to Year 6. The same authors undertook a similar study examining a cohort (N=421) of graduate entry students. Both Pearson correlations and linear regression models were constructed for each outcome variable. GPA at entry demonstrated the most consistent correlation of academic performance through the course, however similar to their prior study of undergraduate students, found that this effect diminished in relative strength as the course progressed.
Generally, a small number of studies highlight the lesser importance of prior academic records on medical school performance. In 2011, authors examined the predictive validity of non-grade-based admission versus grade-based admission relative to subsequent medical school dropout at a Danish university. The student intake was divided into two separate admission strategy groups, those directly admitted based on their having the highest pre-university GPAs and those applicants meeting minimum set requirements in addition to non-grade based admission testing. The results indicated that students admitted purely on having the highest pre-university GPAs had a larger relative risk of dropping out within the first two years of the course. These findings suggest that there were likely to be other factors influencing outcomes, including motivation, as other background social factors in the study were not associated with medical school dropout.

2.3 Selection Procedures and changes to the demographic composition of medical courses

There has been an increasing move to attract medical students from diverse backgrounds in order to address community needs, improve access and reduce workforce shortages in rural and outer urban areas within Australia. In recent years, most universities have introduced special entry quotas and/or special access pathways to recruit those from rural areas or socio-economically disadvantaged backgrounds. However, there is increasing evidence to suggest that selection processes can alter the demographic composition of students within a medical course.
A study by Puddey et al in 2011 compared two cohorts of students undertaking the medical course at UWA. The purpose of the study was to evaluate the possible influence of either the structured interview or UMAT on the demographic composition of students within the medical school. Between 1985 and 1998, students were selected on academic performance alone (N=1402). This student cohort was compared with those selected from 1999 to 2011 who had been selected on the basis of a combination of academic performance, interview score and UMAT (N=1437). Prior to the introduction of the revised selection process, males made up a greater proportion of medical students 56.8% vs. 43.2% females. This pattern reversed in the 1999 to 2011 cohort, with 45.7% males and 54.3% females. Based on predicted modelling, there was no substantial influence of the revised selection process on admissions from public vs. independent high schools than expected (given decreasing public high school enrolments). The study also investigated relative socio-educational advantage based on a composite score of all schools in Australia, known as the Index of Community Socio-Educational Advantage (ICSEA). The ICSEA score is calculated based on a number of variables, where values range from around 500 (extremely disadvantaged) to 1300 (representing schools with students from more advantaged backgrounds). Analysis of this indicated that these scores were significantly higher in those selected from independent high schools compared to public high schools. Irrespective of whether students were enrolled in public or independent schools, those who had attended schools with a higher ICSEA score, also entered with higher overall UMAT scores and academic performance.
The above study also explored the proportion of students from certain regions based on their country of origin; Oceania, NE Asia and SE Asia, UK and Ireland, Southern Asia and Other. In 1998, 34% of students were of NE or SE Asian origin and this fell to 15% in 1999 and to 9% by 2011. Students born in Oceania increased from a mean of 52% (1985 to 1999 cohort) to 69% with the revised selection criteria. In their analysis on selection parameters, the overall UMAT score was not associated with either gender or region of origin. In terms of interview scores, these were significantly higher in females compared to males (1.0 +/- 0.2, p<0.001).

As alluded to in a previous section, Wilkinson et al 33 published a report on the outcomes of removal of the interview at the University of Queensland. The changes in gender ratio were noted in 2009, following removal of the interview as part of the selection process with an increase from 52.2% in 2008 to 57.7%. This proportion remained stable within 1% over the duration of the study. The authors suggested the reason for the change in gender ratio is attributed to better performance by male applicants in section 3 of the GAMSAT (71.5 for males, 68.5 for females). The Pearson correlation demonstrated that Section 3 is more strongly correlated with GAMSAT overall scores, compared with sections 1 and 2.

A study by Puddey and Mercer 40 investigated the potential relationship between UMAT performance and the influence of socioeconomic factors. The purpose of this study was to identify whether the UMAT, which had been introduced to address the under-representation of students from lower socioeconomic backgrounds, was itself influenced by background demographics. The study examined UMAT scores of students between 2000 and 2012 with subsequent regression models utilising
predictors of age, gender, school type, home language, IRSAD (Index of Relative Socioeconomic Advantage and Disadvantage) score, accessibility/remoteness score, Aboriginal or Torres Strait Islander status and state of origin. Following analysis, this study determined that performance in the UMAT overall decreased with age in a linear fashion, with those 30 years and older to have a score 22.7 percentiles lower than those less than 16 years of age. In addition to this, it was also demonstrated that males performed better for the total UMAT score by 3.6 percentiles, performing worse in the UMAT 2 category only. Those students who only spoke English at home outperformed those who spoke Asian (10.4 percentiles), European (12.7 percentiles) and other languages (18.4 percentiles). Performance in UMAT 3 was higher by 2.4 percentiles in those speaking Asian languages. Divergent associations were observed with respect to accessibility/remoteness scores. In terms of the relationship between socio-economic background and UMAT performance, most Australians sitting the UMAT came from the top 2 deciles for IRSAD scores, 50.8%. The IRSAD decile was the strongest predictor of total UMAT score in the final multivariate model, with scores in the highest 2 deciles 13.0 percentiles higher than those in the lowest 2 deciles. The findings from this study provides evidence that aptitude testing may not contribute to the diversification of student cohorts.

In a recent study, Griffin et al examined two samples of students from a single medical school in Australia. The relationship between socioeconomic status, gender, selection variables (UMAT, ATAR and MMI) and performance in medical school were analysed in the respective groups of; applicants to, and graduates of the medical school. Socioeconomic information was derived from the IRSAD (based on the postcode of the applicant’s residence) and ICSEA (for the applicant’s high
school) scores. The authors aimed to examine the impact of home and school socioeconomic status, from application to selection into the undergraduate degree. 50.5% of applicants came from suburbs in the two highest socioeconomic status categories, whereas 32.5% of the state’s population resided in those areas. Significant positive correlations were observed between all the selection variables and socioeconomic status, except for interviews (MMI). Females performed below their male counterparts in UMAT 1, UMAT 3, UMAT total and the ATAR, however achieved significantly higher scores in the interview (MMI). Given these findings, the authors concluded that female applicants of low socioeconomic status are further disadvantaged by the selection process, with the exception of the interview. This bias had been partially overcome in this medical degree by special entry allowances for those of a lower socioeconomic background.

Similar research conducted in the UK 42 analysed socioeconomic data from individuals who sat the UKCAT (UK Clinical Aptitude test) in 2009. The UKCAT was introduced to facilitate broadening access to medical and dental education in the UK. Although 23,719 individuals sat the test, complete information on six demographic predictor variables were available for 8,180 individuals only. These variables included ethnicity, age, school type attended, socioeconomic background, age at which English first spoken and sex. The aim of this study was to determine whether the UKCAT was likely to add value over A-level attainment in the selection process. Results from the multivariable regression demonstrated that A-level attainment was positively predicted by independent/grammar schooling, white ethnicity, younger age and professional backgrounds. The results also demonstrated that all the predictor variables, including having English as a first language and male
gender, were significantly predictive of the UKCAT score, differing slightly to the predictive variables of A-level attainment. These findings suggest possible differences in selection processes and their impact on widening access to potential medical students.

As described in a previous section, a prior study of 421 students in a graduate entry medical programme explored the predictive validity of selection criteria on academic outcomes. Correlations between predictor variables, including the IRSAD score, and entry scores were also determined. In this study, no correlation was noted between the student’s socioeconomic background with any of the entry selection criteria.

A study in Canada also examined the impact of entry measures on student diversity across six medical schools. 5,253 applicants were interviewed and correlations between diversity variables and admission test variables were calculated. Admission variables included MMI scores, GPA and Medical College Admission Test (MCAT) scores. Correlations were calculated between with the admission variables and diversity measures of age, gender, self-declared aboriginal status, size of community of origin and income level. The latter two variables were utilised to reflect socioeconomic status. No statistically significant correlation was noted between gender and the admission variables of MMI, GPA and MCAT. With regard to the diversity variable of age, a positive correlation was noted with the MMI scores, whilst a negative correlation was observed in both the GPA and MCAT. In terms of socioeconomic status, GPA was positively correlated with income level and an upward trend was seen for larger community of origin. These correlations were
small. The MCAT was positively correlated with the size of community of origin with no association to income level.

### 2.4 Demographic background and academic performance

In recognising the influence of selection processes on the socioeconomic demographic of the student population, it is also increasingly evident that a relationship exists between these factors and academic performance during the medical course.

#### 2.4.1 Socioeconomic determinants (age, gender, background)

In the graduate-entry medicine study previously outlined 26, the authors performed regression modelling to investigate the relationship between selection criteria and demographics for the cohort on academic performance. Older students at entry predicted weaker performance throughout the course, with similar results observed in those students in the lower deciles of socioeconomic advantage. The latter finding was observed predominantly in the earlier years of the course, which attenuated as the course progressed.

In a previously described study, the impact of home and school socioeconomic status and gender from application to selection in an undergraduate degree was investigated 41. The findings from the analysis indicated that performance in medical school utilising the student’s final GPA, was not correlated with either of the socioeconomic
variables (ICSEA and IRSAD). Whilst females had a slightly higher GPA than males (4.88 vs 4.73), this relationship was not significant (p=0.20). This relationship did not change after controlling for ATAR and UMAT scores. It was also noted that the diversity variables did not account for any significant variance in GPA.

As described previously, in a new graduate entry medical programme at the University of Wales, the authors sought to examine the links between selection factors and performance outcomes. Data were collected on the initial two cohorts of students entering the course. Demographic data, selection variables (including first degree subject, first degree grade and higher degree) and assessment outcomes (divided into the relevant modules of the first two years of the course) were incorporated in the analysis. The authors did not demonstrate a significant relationship between demographic variables of age, gender, ethnicity and nationality on academic performance. Educational background based on their A-level subjects, subject of their undergraduate degree or degree class did not demonstrate a relationship with final performance.

A study was undertaken at a single institution in the Netherlands to examine the broader question of the relative importance of pre-admission characteristics and past performance in medical school for the prediction of performance in pre-clinical and clinical training. As part of this study, six consecutive cohorts of students were included and some of the predictor variables analysed included ethnicity, gender, age, first-generation university student and having a parent who was a doctor. Year 1 completion within 1 year, pre-clinical course completion within 4 years and the achievement of good clinical performance were the three main outcome measures.
Predictive factors associated with success for Year 1 completion included age greater than 21 years, and a negative association with having a doctor as a parent or being male. The latter gender finding was replicated in an alternative model which incorporated the student’s early performance in medical school. Male gender was also predictive of failure to complete the pre-clinical course within the allocated 4 years.

A more recent review of the GAMSAT over 10 years was undertaken to provide an analysis of candidates’ gender, age, language background, level of academic qualification and background discipline on their performance. In addition, the authors analysed the details on those higher scoring candidates, defined as a typical entry score (TES) which is an overall score of 60 with scores of at least 50 on each of the three sections. An analysis was also performed on 2014 data alone. Demographic data between the years 2005 – 2014 were collected and multiple regression analyses performed with the predictor variables outlined above. The results of the 2014 data demonstrated that males outperformed females overall and in sections 1 and 3 of the GAMSAT. This was observed consistently over the 10-year period. Poorer performance in section 3 was noted with increasing age. This was also seen in its relationship to the TES where the total proportion achieving this score decreased with age. Candidates of an English speaking background were also noted to perform better overall and in each section. Those from a non-English speaking background were less likely to achieve a TES.
2.4.2 Ethnic determinants and disparity

Whilst not a focus of this study, in view of increased student diversity in medical schools, recent literature has explored the relationship between ethnicity and academic performance in specific assessments. In general, it is recognised that students of an ethnic minority perform less well than those from the ethnic majority. A recent study from the Netherlands reported on the outcomes in specific assessments in students from a minority ethnic background. 2432 students entered the course over a six-year period and data including age, gender, ethnicity, pre-university GPA was collected. The outcome measures were based on performance in specific written and clinical examinations. In comparison to the local Dutch students, the non-Western ethnic minority groups performed less well in clinical problem solving tests, language tests and OSCEs. These findings indicate the need to mitigate bias or unintended effects that may occur in assessments in specific groups of students.

2.5 Summary

Predictive validity studies for selection into graduate entry programmes have demonstrated variable and often conflicting results. In this review, recurring themes from prior research have highlighted these inconsistent findings. Firstly, the individual selection tools and the domain and skill that has been measured. Secondly, the graduates socioeconomic and demographic profile, and its influence on assessed outcomes. Finally, the background discipline of students and their performance during the course. The chapter has also explored selection processes
and the effect of this on the demographic profile of students undertaking the graduate entry degrees.

The current research aims to explore the above issues further, pertaining to the new graduate entry MD course at UWA. Of interest, will be whether these findings reaffirm, or conflict with the prior literature presented. It will also serve to detect any bias in selection and assessment outcomes, in addition to the socio-demographic background of students. The following chapter details the methodology by which this will be achieved.
3. Research Methodology

3.1 Introduction

The restructure of coursework degrees at UWA resulted in the change of the previous MBBS undergraduate course to a postgraduate MD course. With the change in course structure, selection processes were also altered and as such, a likely change in the demographic profile of medical students. This presented as a unique opportunity to examine this new, graduate-entry MD course cohort of students, in particular, the entry processes, students’ demographic profile and their academic outcomes.

The following chapter will outline the research methodology in this predictive validity study. Firstly, an overview is provided on the ethics approval process and subsequent study design. The following section of the chapter will explore the rationale behind the study design. The final part of this chapter will outline the method of data collection and the rationale behind the statistical methods employed for this research.

3.2 Ethical Procedures

An ethics exemption application was made to the UWA Human Research Ethics office based on the negligible risk involved, the utilisation of group (not individual) data, the absence of foreseeable risk of harm to participants, and for the benefit of quality assurance and audit of medical school selection processes. In addition, it was
highlighted that there was no identification of individual students, as data were to be collected by faculty admissions staff and each participant assigned a de-identified study identification number. It was indicated that linkage of the student selection data and academic outcomes was to be performed independently of the researcher, and access to an individual’s academic record was not required. A subsequent approval for ethics exemption was granted, approval number RA/4/1/7035 (see, 8.2 Appendix B- Exemption from Ethics Letter).

3.2.1 Recording and Storage of Data

Student demographic information, entry scores and assessment results were collected by faculty admissions staff and entered onto an Excel spreadsheet. Each student was subsequently assigned a unique, de-identified study identification number. Subsequent linkage of the de-identified information to the outcome variables was performed by the chief investigator (CI). This de-identified information was imported to IBM SPSS© statistical software, version 22.0.0.1. The de-identified information was provided to the researcher. All data collected were stored on password-protected, secure drives by the CI and researcher. No paper copies of data were reproduced.

3.3 Study Design and Rationale

This study is a retrospective, non-experimental, exploratory analysis of a cohort of medical students, utilising quantitative methods of data analysis. As the primary aim of the research was to identify a relationship between the baseline demographic
profile of students and their academic outcomes, the quantitative research method was deemed to be the most appropriate, given the availability of both baseline data and assessment measures.

3.4 Study Population

The population for this study was pre-determined by the number of students undertaking their first year of the inaugural MD course at UWA in 2014. There were 208 domestic students enrolled into the course at the commencement of the academic year. This included 129 standard entry, 51 rural, and 21 broadway students. The remaining students (7 students) entered through an alternative entry pathway, as they were of an Indigenous background and entry requirements differed.

3.5 Data Collection

3.5.1 Student Demographic Data

Student demographic data were obtained from their application forms through GEMSAS. Demographic information included the following variables; age, gender, state of application, IRSAD scores, GAMSAT scores, previous bachelor degree and prior academic performance in their undergraduate degree- based on their GPA. The IRSAD score was utilised as a measure of their home socioeconomic status, and based on the applicant’s residential postcode at the time of their application. The IRSAD score is derived from 2011 Australian Census data, and is utilised as an
index of the social and economic conditions of people and households within an area. Scores range from one to ten, with low scores indicative of relatively greater disadvantage and lack of advantage. Higher scores represent relative lack of disadvantage and greater advantage.

An administrative officer of the admissions department of the Faculty of Medicine, Dentistry and Health Sciences, UWA collated the information into a de-identified spreadsheet, utilising student numbers. A study identification number was subsequently created for the purposes of linking demographic data to assessment data.

3.5.2 Interview scores

The matching of students to a university is dependent on the school selection rules, in addition to the student’s preferences as part of their GEMSAS application. Based on these, GEMSAS utilises GPA and GAMSAT results to formulate a course rank. The participating schools offer interviews based on this rank, the composition of which varies from one school to another. Interviews are conducted by each school with the exception of one school and scores are standardised within a school, to allow the use of scores by other participating schools. These standardised scores were provided by GEMSAS.

3.5.3 UWA MD assessment data

Assessment outcomes were provided by the Education Centre in the Faculty of Medicine, Dentistry and Health Sciences at UWA in a de-identified format. Data
were obtained based on the student’s aggregate score for each of their assessments and scaled to a percentage. Both individual assessment and final unit scores were presented in a tabulated format on an Excel spreadsheet, and linked to their study identification number independent of the researcher. Performance in formative assessments were not included as part of the analysis. To address the research questions, only assignment results and final unit scores were used as outcome variables.

The first two years of assessment data were utilised in this study, which included four units; Foundations of Medical Practice 1, Systems Based Learning 1 & 2 and Integrated Medical Practice 1.

The Foundations of Medical Practice Unit summative assessment included three in-semester examinations, two final written examinations, one objective structured practical examination and four written assignments. Each assessment carried a 10% weighting. These assessments covered introductory concepts of the biomedical sciences of anatomy, physiology, biochemistry, genetics, pharmacology and pathology.20

The Systems Based Learning Unit 1 summative assessment included two in-semester examinations, two final written examinations, one objective structured practical examination and five written assignments. Each assessment carried a 10% weighting. Assessments covered the anatomical, physiological, pathological and pharmacological knowledge of human skin, the musculoskeletal system,
neuroscience, haematology, immunology, cardiovascular system and the respiratory system \textsuperscript{21}.

The Systems Based Learning Unit 2 summative assessment included one in-semester examination (10%), two final written examinations (40%), one objective structured practical examination (15%), one structured clinical assessment (10%) and three written assignments/essays (25%), with assessment weighting as indicated. The content assessed for this unit included detailed anatomical, physiological, pathological and pharmacological knowledge of human nutrition, gastrointestinal system, renal system, endocrine system, reproductive systems, human growth, development and ageing, and learning of integration of all human body systems \textsuperscript{23}.

The Integrated Medical Practice Unit 1 summative assessment included, two end-of-year examinations, made up of one written examination (20%) and one objective structured clinical examination (40%). The remainder of summative assessment for the unit (40%) was comprised of in-semester assessments as follows; general surgery (operation worksheet and structured clinical assessment 8%), psychiatry (observed clinical interview 8%), internal medicine (observed case presentation 8%), general practice (chronic disease presentation and chronic disease reflection 8%), geriatric medicine (written case history 4%) and rheumatology (structured clinical assessment 4%) \textsuperscript{22}. 
3.6 Statistical Analysis

Data were analysed using IBM SPSS® statistical software, version 22.0.0.1. Descriptive statistics were calculated for the cohort. For each study variable, normal distributions were checked visually on frequency histograms and P-P plots.

As the purpose of the study was to examine the strength and direction of the relationship between multiple quantitative independent variables (including baseline demographics, entry scores) and multiple quantitative dependent variables (entry scores, assessment outcomes), the use of a Pearson correlation coefficient was considered the most appropriate method of establishing this relationship. Point-biserial correlations were reported for the dichotomised variables. This will be expanded on further in the next sub-sections.

3.6.1 Baseline demographic data

Frequency tables, means and percentages were calculated for baseline demographic data, including age, gender, rurality, pathway of entry, socioeconomic status and discipline of first degree. The discipline of first degree was classified into one of four categories; biological sciences/science, health/allied health, humanities/law/business/commerce and physical sciences. Dummy variables were created for each discipline, rurality, gender, IRSAD scores with subsequent entry into the multivariate linear regression models using IBM SPSS® statistical software, version 22.0.0.1. The IRSAD score was divided into binary variables consisting of
the highest two deciles (1= 9\textsuperscript{th}-10\textsuperscript{th} decile) and the lowest eight deciles (0= 1\textsuperscript{st}-8\textsuperscript{th} decile). The dummy variable utilised for gender was 0=F, 1=M.

3.6.2 Entry scores

Frequency and means were calculated for each of the variables of GPA, interview score and GAMSAT scores, with the latter divided into the three sections GAMSAT 1, GAMSAT 2, GAMSAT 3. In order to explore the relationship between the predictor variables and these entry scores, i.e. two continuous variables, a univariate analysis utilising Pearson correlations was undertaken to determine the presence and strength of an association \(^{49}\). Statistical significance was set as a P value of less than or equal to 0.05.

3.6.3 Assessment outcomes

Univariate analyses using Pearson correlations were performed between each of the predictor variables and final assessment outcomes for reasons as outlined in the prior section. Statistical significance was set as a P value of less than or equal to 0.05.

As one of the aims was to determine the relationship between pathways of entry to the MD course and academic performance, a one-way ANOVA was performed. The one-way ANOVA was utilised as it allowed for comparisons of means between groups \(^{49}\). A Bonferroni correction was applied to adjust for multiple comparisons.
As this is a predictive validity study, in order to elucidate the relationship between assessment outcomes and the full range of predictor variables, multiple linear regression was performed. The dummy variables reported in Section 3.6.1 were retained for the analysis. To understand the weight and relative independent contribution of each predictor variable on the assessment outcomes, standardised coefficients (β) were tabulated. ‘Appendix C’ outlines the 95% confidence intervals for each of these results. To determine how much of the dependent variable (assessment outcomes) is accounted for by the group of independent variables (predictor variables), i.e. the variance, the squared multiple correlation coefficient (R²) were reported. To determine an optimal regression equation and level of importance of each of the predictor variables, backward regression was utilised. Statistical significance was set as a P value of less than or equal to 0.05.

3.7 Summary

In summary, the student assessment data for the initial four units of the MD degree cohort were collated and entered on to an Excel spreadsheet. Assessment data were subsequently linked to each student independent of the researcher to allow for comparisons between the predictor and outcome variables. A unique, de-identified study number was then assigned to each student and data were transferred to IBM SPSS© statistical software, version 22.0.0.1. Correlations and regression calculations were performed and the results are detailed in the following chapter.
4. Results

4.1 Introduction

Following from the methodology applied for the final analysis as described in the previous section, this chapter will present the results of the study findings. Firstly, the baseline demographics of the cohort will be presented, followed by descriptive statistics on the scores of the entry tests and final assessments. The final sections of this chapter will provide a detailed analysis of the relationship between the predictor variables and final assessment outcomes based on correlation and regression analyses.

4.2 Baseline Demographics

A summary of the key baseline demographics is shown in Table 1. 208 students were enrolled at the commencement of the academic year in 2014. There was missing data for 7 students (N=201) who had entered the course via an alternative entry pathway, as their admission requirements differed to the standard pathway (Indigenous background).

There was a gender predominance of females compared to males (58.7% vs 41.3%). The majority of students were under the age of 25 at the start of the course. Of the students enrolled, most had a biological sciences/science background (N=160, 76.9%).
Table 1: Demographic Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean ± SEM, or % of total N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>201</td>
<td>24.58 ± 0.358</td>
</tr>
<tr>
<td>Age (≤25 years, &gt;25 years)</td>
<td>201</td>
<td>71.1% / 28.9%</td>
</tr>
<tr>
<td>Gender (Female/Male)</td>
<td>201</td>
<td>58.7% / 41.3%</td>
</tr>
<tr>
<td>Entry:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>201</td>
<td>25.4%</td>
</tr>
<tr>
<td>Standard</td>
<td>201</td>
<td>64.2%</td>
</tr>
<tr>
<td>Broadway</td>
<td>201</td>
<td>10.4%</td>
</tr>
<tr>
<td>IRSAD (0 = 1st to 8th Decile, 1 = 9th-10th Decile)</td>
<td>195</td>
<td>44.6% / 55.4%</td>
</tr>
<tr>
<td>Discipline Background:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological sciences/science</td>
<td>201</td>
<td>78.6%</td>
</tr>
<tr>
<td>Health/allied health</td>
<td>201</td>
<td>10.0%</td>
</tr>
<tr>
<td>Humanities/law/business/commerce</td>
<td>201</td>
<td>9.0%</td>
</tr>
<tr>
<td>Physical sciences</td>
<td>201</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

4.3 Entry Scores

The mean scores of the predictor variables, including GPA, standardised interview score, total GAMSAT and scores for each GAMSAT section are shown in Table 2. The trend to higher scores for each component is representative of the competitive admission process required to enter the MD degree. A minimum GPA requirement of 5.5 is required as part of the admission criteria. As demonstrated, the mean entry GPA was 6.6. The highest mean score of all the sections of the GAMSAT was section 3 (Reasoning in the biological and physical sciences).
Table 2: Summary statistics of the selection variables

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPA</td>
<td>201</td>
<td>6.6</td>
<td>5.5</td>
<td>7.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Interview</td>
<td>199</td>
<td>76.0</td>
<td>65.7</td>
<td>87.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Total GAMSAT score</td>
<td>201</td>
<td>63.3</td>
<td>53.0</td>
<td>87.0</td>
<td>4.7</td>
</tr>
<tr>
<td>GAMSAT 1 (Reasoning in the humanities and social sciences)</td>
<td>201</td>
<td>60.5</td>
<td>47.0</td>
<td>75.0</td>
<td>5.5</td>
</tr>
<tr>
<td>GAMSAT 2 (Written communication)</td>
<td>201</td>
<td>63.7</td>
<td>50.0</td>
<td>88.0</td>
<td>7.1</td>
</tr>
<tr>
<td>GAMSAT 3 (Reasoning in the biological and physical sciences)</td>
<td>201</td>
<td>64.4</td>
<td>49.0</td>
<td>98.0</td>
<td>9.2</td>
</tr>
</tbody>
</table>

4.4 Outcome Variables

The outcome variables presented in Table 3 include student assessment results of the first two years of the MD course, i.e. one unit per semester. The scores presented are the final adjusted scores for each unit. A minority of students did not complete their units, and therefore data is missing from Table 3.

Table 3: Summary statistics of the scores obtained in assessment outcome variables

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations of Medical Practice</td>
<td>200</td>
<td>74.2</td>
<td>59.1</td>
<td>86.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Systems Based Learning 1</td>
<td>199</td>
<td>74.5</td>
<td>60.3</td>
<td>86.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Systems Based Learning 2</td>
<td>194</td>
<td>74.2</td>
<td>61.0</td>
<td>89.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Integrated Medical Practice</td>
<td>195</td>
<td>71.0</td>
<td>62.0</td>
<td>83.0</td>
<td>4.3</td>
</tr>
</tbody>
</table>
4.5 Univariate Analysis

4.5.1 Univariate analysis between demographic variables and entry scores using Pearson correlations

Correlations between the demographic variables and entry scores are reported in Table 4. Students who were of a younger age at entry performed better in the GAMSAT total score, contributed by a better performance in GAMSAT section 3. These findings were similar to those of a male gender. Students of older age at entry performed better in the structured interview. Those students with a ‘biological science/science’ background performed less well in the interview and both GAMSAT sections 1 and 2, however performed better in GAMSAT section 3. In comparison, the students with a ‘Humanities/law/business/commerce’ background performed better in the GAMSAT sections 1 and 2, with a negative correlation to GAMSAT section 3.

Rural entry students demonstrated lower entry scores, which were significant for the interview, GPA, GAMSAT overall and section 3. Higher scores for the total GAMSAT score, interview and entry GPA were observed in those students from a higher socioeconomic demographic.
### Table 4: Correlation between demographic variables and entry scores in the UWA MD course

<table>
<thead>
<tr>
<th>Demographic Variable</th>
<th>Total GAMSAT Score</th>
<th>GAMSAT 1</th>
<th>GAMSAT 2</th>
<th>GAMSAT 3</th>
<th>Standardised Interview Score</th>
<th>GPA at Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson Correlation</td>
<td>-.142</td>
<td>.009</td>
<td>.032</td>
<td>-.184</td>
<td>.154</td>
<td>.050</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.044</td>
<td>.900</td>
<td>.655</td>
<td>.009</td>
<td>.030</td>
<td>.482</td>
</tr>
<tr>
<td><strong>Gender (0 = F, 1 = M)</strong></td>
<td>Pearson Correlation</td>
<td>.219</td>
<td>.000</td>
<td>-.003</td>
<td>.254</td>
<td>-.077</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.002</td>
<td>.998</td>
<td>.965</td>
<td>.000</td>
<td>.282</td>
<td>.370</td>
</tr>
<tr>
<td><strong>Biological sciences/science (No = 0, Yes = 1)</strong></td>
<td>Pearson Correlation</td>
<td>-.025</td>
<td>-.247</td>
<td>-.282</td>
<td>.153</td>
<td>-.160</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.723</td>
<td>.000</td>
<td>.000</td>
<td>.030</td>
<td>.024</td>
<td>.243</td>
</tr>
<tr>
<td><strong>Health/allied health (No = 0, Yes = 1)</strong></td>
<td>Pearson Correlation</td>
<td>.031</td>
<td>.134</td>
<td>.117</td>
<td>-.048</td>
<td>.152</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.665</td>
<td>.059</td>
<td>.100</td>
<td>.494</td>
<td>.032</td>
<td>.120</td>
</tr>
<tr>
<td><strong>Humanities/law/business/commerce (No = 0, Yes = 1)</strong></td>
<td>Pearson Correlation</td>
<td>-.004</td>
<td>.191</td>
<td>.265</td>
<td>-.168</td>
<td>.038</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.954</td>
<td>.007</td>
<td>.000</td>
<td>.017</td>
<td>.589</td>
<td>.716</td>
</tr>
<tr>
<td><strong>Physical sciences (No = 0, Yes = 1)</strong></td>
<td>Pearson Correlation</td>
<td>.015</td>
<td>.044</td>
<td>.034</td>
<td>-.001</td>
<td>.062</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.835</td>
<td>.538</td>
<td>.636</td>
<td>.992</td>
<td>.386</td>
<td>.565</td>
</tr>
<tr>
<td><strong>Rural Entry (No = 0, Yes = 1)</strong></td>
<td>Pearson Correlation</td>
<td>-.254</td>
<td>-.012</td>
<td>-.078</td>
<td>-.265</td>
<td>-.172</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.000</td>
<td>.862</td>
<td>.270</td>
<td>.000</td>
<td>.015</td>
<td>.000</td>
</tr>
<tr>
<td><strong>IRSAD Decile (0 = 1st to 8th Decile, 1 = 9th-10th Decile)</strong></td>
<td>Pearson Correlation</td>
<td>.153</td>
<td>.056</td>
<td>.097</td>
<td>.118</td>
<td>.182</td>
</tr>
<tr>
<td>Sig. (2-tailed) N</td>
<td>.032</td>
<td>.439</td>
<td>.177</td>
<td>.102</td>
<td>.011</td>
<td>.015</td>
</tr>
</tbody>
</table>

** p<0.01, * p<0.05
4.5.2 Univariate analysis between predictor variables and outcome variables (Assignment results) using Pearson correlations

The relationship between the predictor variables and performance in the assignment component of Foundations of Medical Practice and Systems Based Learning 1 were explored. With respect to the Foundations of Medical Practice unit (Table 5), significant positive correlations were observed in assignment scores for students from higher socioeconomic backgrounds and those who had better interview scores at entry. Both male students and rural entry students had lower assignment scores in this unit. Students with higher interview and GAMSAT section 2 scores performed better in the assignment component of the Systems Based Learning 1 unit (Table 6).
Table 5: Correlation between predictor variables and Foundations of Medical Practice (Assignment Results) in the UWA MD course

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.007</td>
<td>.927</td>
<td>200</td>
</tr>
<tr>
<td>Gender (0 = F, 1 = M)</td>
<td>-.172</td>
<td>.015</td>
<td>200</td>
</tr>
<tr>
<td>Biological sciences/science (No = 0, Yes = 1)</td>
<td>-.061</td>
<td>.392</td>
<td>200</td>
</tr>
<tr>
<td>Health/allied health (No = 0, Yes = 1)</td>
<td>.089</td>
<td>.210</td>
<td>200</td>
</tr>
<tr>
<td>Humanities/law/business/commerce (No = 0, Yes = 1)</td>
<td>-.014</td>
<td>.839</td>
<td>200</td>
</tr>
<tr>
<td>Physical sciences (No = 0, Yes = 1)</td>
<td>.015</td>
<td>.828</td>
<td>200</td>
</tr>
<tr>
<td>Rural Entry (No = 0, Yes = 1)</td>
<td>-.185</td>
<td>.009</td>
<td>200</td>
</tr>
<tr>
<td>IRSAD Decile (0 = 1st to 8th Decile, 1 = 9th-10th Decile)</td>
<td>.200</td>
<td>.005</td>
<td>194</td>
</tr>
<tr>
<td>Total GAMSAT score</td>
<td>.124</td>
<td>.080</td>
<td>200</td>
</tr>
<tr>
<td>GAMSAT 1</td>
<td>.058</td>
<td>.417</td>
<td>200</td>
</tr>
<tr>
<td>GAMSAT 2</td>
<td>.136</td>
<td>.054</td>
<td>200</td>
</tr>
<tr>
<td>GAMSAT 3</td>
<td>.082</td>
<td>.249</td>
<td>200</td>
</tr>
<tr>
<td>Standardised interview score</td>
<td>.192</td>
<td>.007</td>
<td>198</td>
</tr>
<tr>
<td>GPA</td>
<td>.044</td>
<td>.537</td>
<td>200</td>
</tr>
</tbody>
</table>

**p< 0.01, *p<0.05
### Table 6: Correlation between predictor variables and Systems Based Learning 1 (Assignment Results) in the UWA MD course

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-.073</td>
<td>.303</td>
<td>199</td>
</tr>
<tr>
<td>Gender (0 = F, 1 = M)</td>
<td>-.027</td>
<td>.707</td>
<td>199</td>
</tr>
<tr>
<td>Biological sciences/science (No = 0, Yes = 1)</td>
<td>-.015</td>
<td>.832</td>
<td>199</td>
</tr>
<tr>
<td>Health/allied health (No = 0, Yes = 1)</td>
<td>-.071</td>
<td>.322</td>
<td>199</td>
</tr>
<tr>
<td>Humanities/law/business/commerce (No = 0, Yes = 1)</td>
<td>.101</td>
<td>.155</td>
<td>199</td>
</tr>
<tr>
<td>Physical sciences (No = 0, Yes = 1)</td>
<td>-.010</td>
<td>.887</td>
<td>199</td>
</tr>
<tr>
<td>Rural Entry (No = 0, Yes = 1)</td>
<td>-.063</td>
<td>.377</td>
<td>199</td>
</tr>
<tr>
<td>IRSAD Decile (0 = 1st to 8th Decile, 1 = 9th-10th Decile)</td>
<td>.058</td>
<td>.422</td>
<td>193</td>
</tr>
<tr>
<td>Total GAMSAT score</td>
<td>.083</td>
<td>.243</td>
<td>199</td>
</tr>
<tr>
<td>GAMSAT 1</td>
<td>.104</td>
<td>.145</td>
<td>199</td>
</tr>
<tr>
<td>GAMSAT 2</td>
<td>.283</td>
<td>.000</td>
<td>199</td>
</tr>
<tr>
<td>GAMSAT 3</td>
<td>-.039</td>
<td>.588</td>
<td>199</td>
</tr>
<tr>
<td>Standardised interview score</td>
<td>.252</td>
<td>.000</td>
<td>197</td>
</tr>
<tr>
<td>GPA</td>
<td>.005</td>
<td>.944</td>
<td>199</td>
</tr>
</tbody>
</table>

** p< 0.01, * p<0.05
4.5.3 Univariate analysis between predictor variables and outcome variables (final unit results) using Pearson correlations

Correlations between all predictor variables and final scores for each unit for the first two years of the MD course. Older age at entry accounted for poorer final scores during the first year units, however there were no significant correlations with age in the second year of results. Students’ who had a background degree in humanities/law/business/commerce performed poorer than their counterparts did in the first year, with attenuation as the course progressed. In contrast, small but significant positive correlations were seen in students with a background biological sciences/science degree and their academic performance for the first two units of the course.

In those students of a rural background, a negative correlation to academic performance was observed in their first year, with a diminishing association seen the following year.

Whilst there was a small correlation between students’ prior GPA and their final unit outcomes (Foundations of Medical Practice and Systems Based Learning 2), the total GAMSAT score demonstrated the strongest positive correlation of academic performance. This association diminished marginally in strength through the progression of units. GAMSAT section 3 was observed to drive this association with the strongest correlations across the first three units. A lesser but significant positive correlation was also seen with GAMSAT section 1 for the Systems Based Learning 1 and Integrated Medical Practice units.
A significant univariate positive correlation was observed for the standardised interview score and the Integrated Medical Practice unit. Similarly, a correlation was observed between performance in this unit and higher socioeconomic advantage.
Table 7: Correlation between predictor variables and final unit results for the UWA MD course

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pearson Correlation</th>
<th>Systems Based Learning 1</th>
<th>Systems Based Learning 2</th>
<th>Integrated Medical Practice 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.235***</td>
<td>-.217***</td>
<td>-.109</td>
<td>-.057</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.002</td>
<td>.130</td>
<td>.428</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Gender (0 = F, 1 = M)</td>
<td>-.130</td>
<td>.044</td>
<td>-.039</td>
<td>-.111</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.066</td>
<td>.534</td>
<td>.589</td>
<td>.124</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Biological sciences/science (No = 0, Yes = 1)</td>
<td>.149*</td>
<td>.140*</td>
<td>.077</td>
<td>-.033</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.035</td>
<td>.049</td>
<td>.284</td>
<td>.648</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Health/allied health (No = 0, Yes = 1)</td>
<td>.062</td>
<td>.015</td>
<td>.025</td>
<td>.106</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.382</td>
<td>.830</td>
<td>.735</td>
<td>.140</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Humanities/law/business/commerce (No = 0, Yes = 1)</td>
<td>-.245**</td>
<td>-.190**</td>
<td>-.083</td>
<td>-.103</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.007</td>
<td>.250</td>
<td>.153</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Physical sciences (No = 0, Yes = 1)</td>
<td>-.063</td>
<td>-.048</td>
<td>-.104</td>
<td>.074</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.374</td>
<td>.497</td>
<td>.149</td>
<td>.301</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Rural Entry (No = 0, Yes = 1)</td>
<td>-.300**</td>
<td>-.183**</td>
<td>-.147</td>
<td>-.028</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.010</td>
<td>.041</td>
<td>.701</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>IRSAD Decile ( 0 = 1st to 8th Decile, 1 = 9th-10th Decile)</td>
<td>.227**</td>
<td>.135</td>
<td>.101</td>
<td>.201**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.062</td>
<td>.167</td>
<td>.006</td>
</tr>
<tr>
<td>N</td>
<td>194</td>
<td>193</td>
<td>188</td>
<td>199</td>
</tr>
<tr>
<td>Total GAMSAT score</td>
<td>.366***</td>
<td>.330**</td>
<td>.304**</td>
<td>.201**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.005</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>GAMSAT 1</td>
<td>.163</td>
<td>.197</td>
<td>.148</td>
<td>.197</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.021</td>
<td>.005</td>
<td>.040</td>
<td>.006</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>GAMSAT 2</td>
<td>.113</td>
<td>.147</td>
<td>.137</td>
<td>.142</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.111</td>
<td>.039</td>
<td>.058</td>
<td>.048</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>GAMSAT 3</td>
<td>.345**</td>
<td>.279**</td>
<td>.256**</td>
<td>.119</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.099</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
<tr>
<td>Standardised interview score</td>
<td>.106</td>
<td>.153*</td>
<td>.101</td>
<td>.249**</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.138</td>
<td>.032</td>
<td>.164</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>198</td>
<td>197</td>
<td>192</td>
<td>193</td>
</tr>
<tr>
<td>GPA</td>
<td>.176</td>
<td>.100</td>
<td>.176</td>
<td>.014</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.013</td>
<td>.159</td>
<td>.014</td>
<td>.845</td>
</tr>
<tr>
<td>N</td>
<td>200</td>
<td>199</td>
<td>194</td>
<td>195</td>
</tr>
</tbody>
</table>

** p<0.01, * p<0.05
4.6 Multivariate analysis

4.6.1 Backward Regression models of the Relationship between Predictor variables and Academic performance in Years 1 and 2 of the UWA MD course

Table 8 outlines the final backward multivariate linear regression models for the relationship between predictor variables with academic performance in the first two years of UWA MD students. There were no independent predictor variables that performed consistently across the four units assessed in this study. GPA at entry and GAMSAT section 3 were the most consistent predictors of academic performance in the first three units of the course. This relationship was not observed for the Integrated Medical Practice unit. GAMSAT section 1 was also an independent predictor in three of the four units. Similar to the univariate analysis, students from a humanities background demonstrated a poorer performance in the majority of final unit scores.

In terms of demographics, older age at entry predicted poorer performance in the first year with no significant relationship noted in year two. Female gender was associated with better performance in the Foundations of Medical Practice and Integrated Medical Practice units, with no relationship observed for the two Systems Based Learning units. A small but significant association was observed in the performance of students of a higher socioeconomic background (based on the IRSAD) for the Integrated Medical Practice unit only, with no relationship observed with the initial three units.
The $R^2$ values diminished from 36% in the Foundations of Medical Practice Unit, to 19% for the final two units, indicating that these predictors account for a small amount of the variance of the final unit scores.

Table 8: Backward multivariate linear regression models of the relationship between predictor variables for UWA MD students and academic performance as assessed by final unit scores.

<table>
<thead>
<tr>
<th>Predictor Variable</th>
<th>Foundations Medical Practice</th>
<th>Systems Based Learning 1</th>
<th>Systems Based Learning 2</th>
<th>Integrated Medical Practice 1</th>
<th>R squared (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>β -.152</td>
<td>β -.184</td>
<td>β -.165</td>
<td></td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td>Sig. .023</td>
<td>Sig. .013</td>
<td>Sig. .022</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (0 = F, 1 = M)</td>
<td>β -.245</td>
<td>β -.165</td>
<td></td>
<td></td>
<td>23%</td>
</tr>
<tr>
<td></td>
<td>Sig. .000</td>
<td>Sig. .022</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural Entry (No = 0, Yes = 1)</td>
<td>β</td>
<td></td>
<td></td>
<td></td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRSAD</td>
<td>β .152</td>
<td></td>
<td></td>
<td></td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>Sig. .044</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPA</td>
<td>β .164</td>
<td>β .150</td>
<td>β .216</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. .016</td>
<td>Sig. .045</td>
<td>Sig. .003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interview Score</td>
<td>β .160</td>
<td>β .188</td>
<td>β .164</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. .018</td>
<td>Sig. .012</td>
<td>Sig. .031</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAMSAT 1</td>
<td>β .265</td>
<td>β .177</td>
<td>β .227</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. .000</td>
<td>Sig. .018</td>
<td>Sig. .003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Health/Allied Health Background</td>
<td>β</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanities/Law/Business/Commerce</td>
<td>β -.250</td>
<td>β -.219</td>
<td>β -.158</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. .000</td>
<td>Sig. .003</td>
<td>Sig. .041</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Sciences</td>
<td>β</td>
<td></td>
<td>-178</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td></td>
<td>.013</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Only significant (p<0.05) values have been reported.
4.6.2 Backward Regression models of the Relationship between Entry scores and Academic performance in Years 1 and 2 of the UWA MD course

In the analysis of entry scores and academic performance, GAMSAT section 3 predicted academic outcomes most consistently (Table 9). This relationship was observed over the course of the first three units with a diminishing association as the course progressed. The interview was an independent predictor of performance in the Integrated Medical Practice 1 Unit. A positive relationship was also seen with the GPA in the Foundations of Medical Practice and System Based Learning 2 units. The $R^2$ values were low, indicating that entry scores account for a small amount of the variance of the final unit scores. These diminished as the course progressed.

Table 9: Backward multivariate linear regression models of the relationship between entry scores and academic performance as assessed by final unit scores.

<table>
<thead>
<tr>
<th></th>
<th>Foundations Medical Practice</th>
<th>Systems Based Learning 1</th>
<th>Systems Based Learning 2</th>
<th>Integrated Medical Practice 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPA</td>
<td>$\beta$</td>
<td>.181</td>
<td>.201</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>.008</td>
<td>.005</td>
<td></td>
</tr>
<tr>
<td>Interview Score</td>
<td>$\beta$</td>
<td></td>
<td></td>
<td>.225</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td></td>
<td></td>
<td>.003</td>
</tr>
<tr>
<td>GAMSAT 1</td>
<td>$\beta$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAMSAT 2</td>
<td>$\beta$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAMSAT 3</td>
<td>$\beta$</td>
<td>.317</td>
<td>.254</td>
<td>.226</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>.000</td>
<td>.000</td>
<td>.001</td>
</tr>
<tr>
<td>$R$ squared (%)</td>
<td></td>
<td>18%</td>
<td>14%</td>
<td>13%</td>
</tr>
</tbody>
</table>
4.6.3 Backward Regression models of the Relationship between Demographic variables and Entry scores of the UWA MD course

Similar to the univariate analysis, being from a health science background and older age at entry predicted a better overall performance in the interview. Male students performed better in the GAMSAT overall. Weaker performance across all three selection criteria was strongly associated with students of a rural background. No statistically significant relationships were observed between socioeconomic advantage and performance in the selection criteria. The demographic variables explained 14%, 13% and 13% variation in the GAMSAT total score, Interview and GPA respectively.

Table 10: Backward multivariate linear regression models of the relationship between demographic variables and entry scores.

<table>
<thead>
<tr>
<th>demographics</th>
<th>GAMSAT total</th>
<th>Interview</th>
<th>GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result 160.226</td>
<td>.180</td>
<td>.014</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td>.226</td>
<td>.001</td>
</tr>
<tr>
<td>Rurality</td>
<td>-.209</td>
<td>-.191</td>
<td>-.310</td>
</tr>
<tr>
<td>IRSAD</td>
<td>.005</td>
<td>.011</td>
<td>.000</td>
</tr>
<tr>
<td>Health/Allied Health Background</td>
<td>.165</td>
<td>.021</td>
<td></td>
</tr>
<tr>
<td>Humanities/Law/Business/Commerce</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Sciences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R squared (%)</td>
<td>14%</td>
<td>13%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Reported values= significant at p<0.05 value
4.7 ANOVA

There was a statistically significant difference in scores between the standard entry and rural groups as determined by one-way ANOVA for Foundations of Medical Practice [F(2,197)=10.451, p=0.000]. A Bonferroni post-hoc test revealed statistically significant lower scores in the rural-entry group (71.7 ± 5.46, p=0.000) compared to the standard entry group (75.3 ± 4.64).

There was a statistically significant difference in scores between the standard entry and rural groups as determined by one-way ANOVA for Systems Based Learning 1 [F(2,196)=5.538, p=0.031]. A Bonferroni post-hoc test revealed statistically significant lower scores in the rural-entry group (72.9 ± 5.68, p=0.025) compared to the standard entry group (75.1 ± 4.74).

There were no statistically significant differences in scores for Broadway groups compared with standard and rural entry for Foundations of Medical Practice and Systems Based Learning 1. In addition to this, there were no differences in scores for all groups for the subjects of Systems Based Learning 2 and Integrated Medical Practice 1.

4.8 Summary

This chapter has presented the results of the analyses. To summarise, it has shown that prior academic performance and GAMSAT section 3 were the most consistent predictors of academic performance in the first three units of the course, whilst
students from a humanities background predicted a poorer performance in most of the final unit scores. Older age at entry predicted poorer performance in the first year with no significant relationship noted in year two.

In relation to the demographic variables and performance in selection criteria, a health science background and older age at entry predicted a better overall performance in the interview. In terms of gender bias of the selection criteria, male students performed better in the GAMSAT overall score. Weaker performance across all three selection criteria was strongly correlated to students of a rural background. The next chapter will discuss these findings and implications of the study in further detail.
5. Discussion

5.1 Introduction

This research is an analysis of the association between student entry and demographic factors and their academic outcomes in the first two years of the UWA MD degree. The primary research questions that the study aimed to address:

- What is the relationship between the UWA MD course selection criteria (GPA, Interview, GAMSAT) and the demographic profile of students?

- What is the relationship between the background demographic characteristics of students enrolled in the UWA MD course and their academic outcomes at the end of the first two years of their degree?

- What is the relationship between student selection criteria and their academic outcomes at the end of the first two years of the UWA MD degree?

- What is the relationship between the pathway of entry (Standard, Rural and Broadway) to the UWA MD course and subsequent academic performance?

This discussion chapter aims to summarise the results of the study and make comparisons to prior literature. In addition to the above, potential limitations of the research are also discussed.
5.2 UWA MD course selection criteria and the demographic composition of students

The demographic of the medical student population is considered important, as the doctors who graduate are required to both reflect and serve the needs of the wider community. The term diversity is often utilised to suggest that broadening the student demographics may improve healthcare based on the notion that students of similar backgrounds to their patients would lead to better health outcomes. This association has yet to be clearly defined, however the argument for this has been gaining momentum. Cohen et al. put forward a case for improving cultural diversity amongst the medical workforce, arguing that a diverse workforce will “help to expand health care access for the underserved, foster research in neglected areas of societal need, and enrich the pool of managers and policymakers to meet the needs of a diverse populace”. As discussed previously within the literature review, prior studies have examined the impact of entrance aptitude testing on the socioeconomic demographics of the student cohort in the UK and also in Australia. Whilst this study does not address ethnicity as part of the socioeconomic demographic and student diversity, this has been studied in the literature previously.

As shown in the univariate analysis of predictor variables vs selection criteria, the findings from this research demonstrated significant associations between greater relative advantage (and relative lack of disadvantage) based on the IRSAD, and better performance in the selection criteria, specifically, the GAMSAT total score, interview score and GPA. This appears to reflect the results of a previously
referenced study at the same institution examining this relationship in an undergraduate medical degree and the UMAT score \(^{40}\), where the multivariate regression model demonstrated the IRSAD decile as the strongest predictor of the total UMAT score. When this association was explored in the multivariate analysis in the current study, IRSAD was not a significant predictor, therefore showing minimal effect with regards to selection. This may be explained by the alternative entry of pathway at UWA, i.e. Broadway entry, thereby reinforcing its importance in the selection of students into the course.

In terms of the demographic profiles of medical students, previous studies have also examined the relationships of selection criteria with both age and gender. A study of 23 medical and dental schools in the UK examined the UKCAT to determine whether it added value to the selection process for school leaver students \(^{53}\). Additionally, the study sought to explore whether the UKCAT could reduce socioeconomic bias. The authors determined that male applicants performed better in the UKCAT overall, and in both the verbal and reasoning components compared with their female counterparts. Similar results were demonstrated in a review of the predictors of GAMSAT performance over a 10-year period, where males outperformed females in the overall GAMSAT scores, and both section 1 and 3 \(^{45}\). In the current study, males had higher GAMSAT overall and Section 3 scores in the univariate analysis (\(p<0.01\)). The multivariate analysis also demonstrated a significant relationship between male gender and better performance in the GAMSAT overall (table 10). The overall effect of this gender advantage in the UWA course is unclear given the infancy of the MD course, and that the current gender ratio for this cohort favoured females 58.7\% vs 41.3\% (Table 1).
In the multivariate analysis, an older age at entry to the course predicted better performance in the interview. This finding is not surprising given that the structured interview had been designed to assess a range of qualities and situations, and it is more likely that older applicants will perform better in this setting given their greater educational and life experience. This positive association also reflects a previous Canadian study examining the correlation between age and the MMI 43.

The multivariate analysis has demonstrated that students from a rural background performed poorer than their counterparts in all three components of the admission testing. As the majority of these students entered the degree on an alternative pathway, this is unlikely to have affected the final demographic composition of students within the cohort. It does however reflect the need to utilise alternative pathways of entry to ensure that the medical student cohort is representative of the wider community in which they will serve in the future. These findings are similar to those demonstrated by Puddey et al 54 in an analysis of the UWA undergraduate medical degree between 2006 and 2011, where students’ intention to practice rurally and the predictive factors for this were assessed. Part of this analysis examined the selection criteria and socio-demographic differences in those students from a rural vs an urban background. Similar to the results from this current study, the authors determined that rural students had lower academic entry scores, interview scores and lower UMAT percentile scores. An association was also noted between rural students and an increased likelihood of a background of reduced socioeconomic advantage and increased socioeconomic disadvantage, based on the IRSAD score 54.
Interestingly, two prior studies have shown no disadvantage to rural applicants through the admissions process. A previous study by Wright et al at the University of Calgary examined the success of rural background applicants compared to those of an urban background in the medical school admission process. The authors found that over a 10-year period, mean interview scores did not differ between groups. Overall, applicants from rural backgrounds were not disadvantaged or discriminated against through the progression of the application process. Similar to this, a study at the University of Adelaide found no significant associations between a rural background and lower success at any point during the admission process.

Aside from better performance in the interview by students with a health/allied health background, no other associations were observed between their primary degree and selection criteria. Groves et al also determined no disadvantage in the selection process to those students from non-biological science backgrounds.

Based on the findings of this study, a degree of uncertainty remains regarding the influence of selection factors on the demographic composition of the UWA MD course, given no prior comparative cohorts. The results do however highlight better performance by the male gender in the GAMSAT with the contrasting finding of gender balance in the group favouring females. The study also highlights the need to have in place an alternative pathway of entry for those students from a rural background with the view to promote the return of medical graduates to rural areas in the longer term. Government initiatives including the Medical Rural Bonded Scholarship (MRBS) and the Bonded Medical Places schemes are also in place to address this, however the effectiveness of these are currently uncertain.
5.3 Background demographic characteristics of UWA MD students and their academic outcomes

As discussed in a previous section, associations exist between socio-demographic profiles of students entering medical degrees and their subsequent academic outcomes during the course. These findings have been further validated by this study.

In the univariate analysis, a significant association was shown between older age and poorer performance in the first year of the course, with attenuation in the second year. This was also confirmed in the multivariate analysis, with a significant relationship in the first year units and no association in the second year. The reason for this relationship is unclear given that prior studies examining age and academic performance have provided mixed results \(^\text{26,27,60,61}\). It could be postulated that younger students at entry have continued their education from secondary school to an undergraduate degree directly, and are better prepared for university assessments. Older students may have had a period of employment or other work between their undergraduate degree and entry to this course, with lesser familiarity and preparedness of university assessments. This may explain the ‘levelling-out’ of academic performance in the second year.

In terms of gender, the multivariate analysis demonstrated correlations between female gender and better academic performance in the Foundations of Medical Practice and Integrated Medical Practice Units. This observation is interesting given
that no association was seen in relation to gender and the Systems units, which suggests a difference in gender performance either due to the method of assessment, or the content of the ‘Systems’ units. A previous study in 2003, has demonstrated that female gender was an independent predictor of performance in a clinical examination. This finding appears to reflect the results of the current study, where the structure of the Integrated Medical Practice unit is geared towards clinical, in-training assessments.

In this study, a small but significant association was seen between greater socioeconomic advantage and performance in the Integrated Medical Practice unit only. This finding is somewhat reassuring given that the previously described study by Puddey et al indicated a negative effect of coming from a more disadvantaged socioeconomic background in the earlier years of the graduate-entry medical course. The IRSAD and ICSEA were both utilised to demonstrate a relationship between socioeconomic status and the final GPA of medical students at the completion of their undergraduate degree. Similarly, the observed findings from this particular study did not find an association between socioeconomic status and the academic outcomes at the end of their course.

Students with a humanities/law/business/commerce background had lower final scores for the first two units of the MD degree in both the univariate and multivariate analysis. This can be explained by the predominance and focus of the science-oriented units in the first few units of the course. Previous literature has shown positive associations between a background in health and science throughout all
units of a medical degree \(^{26}\), however in the current study, there was no association observed in the multivariate analysis (health/allied health degree).

The multivariate regression model variance for the first two units were 36% and 23% respectively. This is similar, if not higher than prior studies \(^{13,25,26}\) and is a likely reflection of the inclusion of a more extensive set of variables. It is worth noting that in this study, variance included entry testing scores (GAMSAT, GPA and interview scores). One of the main issues in predictive validity studies is the lack of research evaluating non-academic attributes, i.e. motivation, personality and values. These are likely to be predictors of success, however determining an appropriate measure of these attributes remains challenging.

As mentioned, this study has not replicated findings from prior studies where better performance was achieved in those from a health sciences background. It has however demonstrated poorer academic outcomes in those from a humanities/law/business commerce background.

### 5.4 Predictive validity of the selection criteria on academic outcomes

As presented in the earlier literature review, debate exists regarding the predictive validity of selection criteria and final academic outcomes. The aim of the research was to clarify this specific relationship within one cohort of the UWA MD course and build on findings from previous literature relating to this topic.
In the analysis, only the first two years (i.e. four units) of the four-year degree were assessed. The univariate analysis demonstrated a consistent positive association between the overall GAMSAT score and each of the four units. Linear regression suggested contributions to this relationship from both sections 1 and 3 of the GAMSAT. The closest association was observed in section 3 of the GAMSAT in the first three units of the course, which appears in keeping with course progression given the initial science-based units, i.e. Foundations of Medical Practice and Systems Based Learning. Similar findings, where the GAMSAT predicts academic performance early in the course, have been observed in previous literature. This provides support to the notion that the GAMSAT can be prepared for through prior study, particularly given the large science-based component to the assessment. It is therefore not surprising that students are more likely to perform better academically in the initial units of a medical degree, where basic science subjects often predominate. Interestingly, clinical integration in teaching occurs earlier in the UWA MD course within the Systems Based Learning units compared to the prior literature where the initial units of the course are typically ‘pre-clinical’, yet there still appears to be an association. This may also reflect the integrated nature of the assessment within the MD degree. In contrast, Wilkinson et al in one of the earlier predictive validity studies in Australia, found very little correlation between performance in the GAMSAT and academic performance throughout the course.

One of the secondary aims of the study was to explore a possible relationship between predictor variables and academic performance in assignments specifically. Mixed results were observed in this regard. Of the admissions tests, a positive correlation was determined between the standardised interview score and the total
assignment score for the Foundations of Medical Practice unit. Section 2 of the GAMSAT demonstrated a positive association with the total assignment score of the Systems Based Learning-1 unit. Whilst the latter relationship is expected given that assignments require adequate written communication skills (i.e. GAMSAT Section 2), the former association is more surprising and without clear explanation. The assignments within the course involved critical analysis of literature covering various topics as discussed earlier. Overall, there is a paucity of published evidence relating to standardised interviews and their association with components of in-course assessments, specifically, written assignments. It is possible that this finding is connected to communication skills in general.

One of the strongest associations observed in predictive validity studies has been the association between prior academic record and final course outcomes. In the multivariate analysis of this study, the GPA as a measure of prior academic performance, demonstrated significant positive associations in both the Foundations of Medical Practice and Systems Based Learning units. This association was not seen in the Integrated Medical Practice unit. These findings are not surprising given that they parallel previous graduate-entry studies on predictive validity, where assessments in the earlier stages of the medical degree tend to be more academically-based. Similar studies of graduate-entry degrees in Australia have been fairly consistent in terms of this observed association. A recent systematic review by Patterson et al has further confirmed this finding and highlights the issues of the use of prior academic performance alone, given its lack of discriminatory power when most students entering medical degrees have high grades at the outset. This reinforces the need for multiple selection tools in determining the student cohort.
In the linear regression modelling, the interview scores showed positive but inconsistent associations to academic outcomes. An association was observed with the interview score and both Systems Based Learning-1 and the Integrated Medical Practice units (Table 7). In the multivariate analysis examining selection criteria and final unit scores (Table 9), a positive association was observed between the standardised interview and the Integrated Medical Practice unit only. This finding may substantiate the integrative nature of assessments within this unit, its similarities with the standardised interview and the constructs assessed. Prior studies have also highlighted stronger associations between performance in the structured interview and clinically-based units \(^{16,26,64}\). The University of Queensland removed the interview from their selection process based on findings of a modest relationship in terms of final outcomes in a study of their selection criteria \(^{13}\), with no effect on communication skill outcomes at the end of the first year \(^{65}\). As discussed in the literature review, this change led to a gender bias in students selected with a marked increase in males entering the course \(^{33}\).

In a recently published study of three medical schools in Australia, with similar design to the current analysis examining the predictive power of the interview, a negative association was observed in relation to the academic outcomes (based on the GPA) \(^{66}\). Whilst a negative association was not seen in the current analysis, the relationships were not significant for the first three units assessed, with only the Integrated Medical Practice unit demonstrating a positive relationship. The mixed findings of the effectiveness of interviews are likely to indicate their purpose in assessing non-cognitive ability rather than academic performance. In addition, this
variability may also reflect the differences in the format of the interview at a particular institution.

The relationships observed in this study between prior academic performance and higher final scores early in the degree, in addition to the standardised interview and better outcomes in the latter unit of the degree, suggests that outcome measures and assessment types during course progression may have some influence. Potentially, alterations of the curriculum or type of assessment to include greater clinical integration in the earlier stages of the degree could impact upon these relationships favourably. Notwithstanding the unknown effect and clinical implication of this in the longer term during ‘real world’ clinical practice.

The combination of the three selection tools (GAMSAT, GPA and interview) in the model utilised in this study predicted between 10% to 18% performance in the first two years of the course. This finding is in keeping with most of the prior predictive literature surrounding this topic, including a more recent study from Flinders University where their model account for between 7.1% to 29% of performance (across four years) 63.

One of the important factors to note is that the outcomes of the predictive validity analyses above do not necessarily transfer to the student’s eventual practice as a doctor. This association is unclear, as the admission testing of students and the subsequent predictive validity studies are assessing ‘within course’ outcomes. There has been a long held assumption that assessments through medical courses assess the
characteristics that define a ‘good physician’ however further research in this regard is required.

5.5 Pathway of entry

As discussed in the literature review, there has been a shift within the admissions processes of medical schools to increase the diversity of students entering the course, particularly those students from traditionally underrepresented groups 67,68. There is increasing evidence to support the notion that improved representation of medical graduates from more disadvantaged groups improves healthcare outcomes and increased medical practice in these areas 69.

As observed in the study, there exists an association between rural entry students and poorer performance in the first year of the MD course compared with both the standard-entry and broadway-entry students. This finding had attenuated by the second year with no differences observed. However, rurality was not an independent predictor of performance in the first two years of the course, as observed in the multivariate analysis. A recent study at the James Cook University College of Medicine and Dentistry observed significantly lower academic scores in rural graduates across years 1 to 3, i.e. the more theory-based years of the course. This difference became insignificant in year 4, and by years 5 to 6, little difference was noted between the groups 70. These findings appear to reflect the observations from the current study, where the academic performance of rural-entry students in their second year, i.e. course units with greater clinical integration is comparable to the standard-entry students. The reasons for this remains unclear, although it has been
posited that these students may have limited educational opportunities in rural and remote areas, or that they may be the first in their family at university with lesser support in the initial years of university \(^7^0\). One could assume that these factors may also explain the poorer academic entry scores observed in rural students. Overall, it remains reassuring that rural students in this course do not show poorer performance as the course progresses.

### 5.6 Limitations of the study

This study provides an understanding of the socioeconomic demographics and predictors of both admission criteria and final academic outcomes of the new MD course at UWA. It does however only provide an insight in to the early stages of the course given the analysis of a single cohort within a single institution. Therefore, the results are not generalizable. Additionally, the study has examined data from the first two, of a four-year degree, and therefore a future analysis incorporating the entire four years will provide a better overall assessment of the course.

As alluded to previously, the current study is a cross-sectional design and this limits longer-term, longitudinal evaluation. Many prior predictive validity studies in this domain, this study included, are subject to the problem of the specific outcomes that are to be predicted by the selection methods, i.e. performance in assessments during medical school rather than indicators relating to future clinical practice.

The predictive relationships observed in this analysis are small, although similar to other predictive validity studies. This is expected given the range of factors that may
influence assessment performance, including non-academic attributes such as empathy, integrity, personality and situational awareness.

The use of the IRSAD as a surrogate of the student’s socioeconomic demographic may be less reliable given that it is based on based on the postcode of their residence and not necessarily representative of an individual’s socioeconomic status. Students may have moved to urban areas within proximity of their undergraduate institution in the years prior to the commencement of this MD degree. This limitation is likely to have lessened the strength of the reported association.

As outlined in the research methodology, the discipline of each applicant’s first degree was grouped into one of four broader categories which was within the limitation of the data provided at baseline. In order to further define the relationship between their undergraduate degree and their academic outcomes, future studies may seek to clarify their degree major and possibly the extent to which they have undertaken employment in a clinical setting previously. The latter would be more relevant for those with a health sciences background.

At the time of the analysis, the breakdown of assignments vs overall scores was not available for the second year units. Therefore, only the first two units of the course were assessed with regard to assignments specifically.

5.7 Recommendations for future research

Potential future research to extend the findings of this study includes;
1. **Extension of the study to the complete four years of the UWA MD degree.**

By extending the study, with an analysis of all units and assessments of this cohort from Year 1 to Year 4, this will allow for an in-depth analysis of the influence of demographic and predictive factors through course progression. Findings from such a study would provide information on whether the association of these factors attenuate over time. Results may also be more indicative of the ‘real-world’ setting, as students will be closer to their practice as a clinician.

2. **Extension of the study to include subsequent year groups (i.e. more cohorts) progressing through the course.**

The inclusion of multiple cohorts will allow for greater generalisability and further substantiation of the results of the current study. Additionally, given that the MD degree is a new course at UWA, this will also provide an analysis of the socio-demographic composition of the course, particularly if there are changes made to both entry criteria and course assessments over time. Findings from an extension to the study of this nature, will provide a clearer understanding of whether any bias exists due to the overall increase in numbers of students analysed.

3. **Undertake further analysis utilising other socioeconomic and predictive factors, not already included in the current study.**

There is the potential to expand the study to include other predictive factors to determine if there are other potential determinants of both the demographic composition of students and academic outcomes. e.g. Language spoken at home (English vs Non-English speaking backgrounds), household income levels,
secondary education (government school vs private school), parents who are doctors and academic performance during secondary education. Understanding the influence of these factors, and the subsequent alteration to the demographic composition of the student cohort may impact upon the medical workforce in the community, i.e. will it reflect the expectations of the wider community?

4. *Determining the presence of an association between predictor variables and components of the curriculum.*

The structure of the UWA MD curriculum has been explained in Chapter One. Like the analysis on predictor variables and specific assignments (Table 5 and Table 6), determining an association between these variables and the various phases of the UWA MD curriculum would allow for a greater understanding of any potential bias. Alterations to the curriculum would need to be implemented if a significant association is thought to exist to ensure equity and fairness among the students and their academic performance.

5. *Exploring component scores within the structured interview and their effect on specific in-course assessments.*

Similar to the analysis involving the various sections of the GAMSAT (i.e. GAMSAT Sections 1,2 and 3), there exists a possibility to explore the various component scores of the structured interview and their correlation to in-course assessments. It could potentially serve to identify components of the interview that have significant positive associations with assessments thought to be representative of the qualities ultimately suited to the overall practice of medicine, including non-academic attributes and skills.
5.8 Summary

This chapter has expanded on the results of the study, with comparisons and reference made to the prior predictive validity studies. The current study has reinforced previous studies exploring the association between course selection criteria and the demographic composition of the student cohort, specifically with a gender bias towards males due to higher GAMSAT scores. Additionally, it also reiterates previous literature in which prior academic outcomes and GAMSAT (sections 1 and 3) tend to be stronger predictors of performance in-course, particularly in the initial years of the degree. This is contrasted to a poorer performance initially in those students with a prior academic degree in the humanities/law/commerce/business, and no association between outcomes and a health/allied health background. Rurality was not a predictor of performance in the first two years of the course.
6. Summary and Conclusions

This study has extended the current understanding of the predictive validity of admission testing, background demographics and socioeconomic factors in the context of graduate-entry medical courses.

Chapter One has provided a background to the study, with an exploration of the current MD degree structure at UWA, including its selection criteria, course curriculum and methods of assessment. Chapter Two has highlighted prior predictive validity literature on medical student selection methods, in addition to the student socio demographic determinants relating to both selection and course academic outcomes. Chapter Three has outlined the research methodology and the subsequent statistical analyses. Chapters Four and Five have provided the results of the study with an exploration in to the findings, and its comparisons to prior literature.

Overall, the study has reinforced previous literature regarding the association between prior academic outcome and GAMSAT as stronger predictors for performance in-course, particularly in the initial years of the degree. Prior academic background in the humanities/law/commerce/business appears to be a disadvantage in terms of performance in the early years of the course. This study has confirmed the previous findings of a gender effect with higher GAMSAT scores attained by males, with the largest contribution from Section 3. In this cohort, gender balance favoured females however continued monitoring of this will be required.
Additionally, this study reinforces the need for ongoing provision of alternative pathways of entry to these courses to maintain diversity of the student cohort. In particular, those from rural backgrounds and possibly those students applying from areas of lower socioeconomic status. It is however reassuring that the study has demonstrated no clear evidence of disadvantage to these students through course progression.

As with many prior studies, this research has identified the importance and utility of multiple selection tools in the admissions process. The issue of how best these criteria are combined (including; order of administration, ranking and scaling) in this process remains unclear and outside the scope of the study. As demonstrated, the impact of socioeconomic determinants on these criteria cannot be ignored in view of the associations demonstrated in the analysis. Fortunately, further studies in relation to this are gaining momentum, specifically with regarding to the predictors and outcomes of the GAMSAT, a critical tool in the selection process in Australia. The question of determining the combination of tools to best select students who not only perform well during the course, but later in clinical practice also remains unanswered.
7. References

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21. The University of Western Australia. Faculty of Medicine, Dentistry and Health Sciences- Systems-based Learning (Unit Guidebook). Crawley: The University of Western Australia; 2014.
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52. Woolf K, Potts HW, McManus IC. Ethnicity and academic performance in UK trained doctors and medical students: systematic review and meta-analysis. BMJ. 2011;342:d901.


8. Appendix

8.1 Appendix A - Structured Interview

- Interviews were conducted by a panel of two consisting of a male and a female, a university member and a community member; and all interviewers were required to re-train each year.

- Six criteria were assessed each year using three set questions for each criterion. The seventh criterion *Communication skills* was assessed across the responses to the set questions.

- The interview had a highly structured format in which all applicants were asked exactly the same questions and only standard prompts were used.

- The basic format of the interview remained consistent over the years, with changes to the rating scales in 2006. Originally the seven criteria were each scored 0 – 4, more recently each criterion was scored 0 – 6.

- The final score was a consensus score determined after each interviewer had assessed the responses independently against clearly defined rating scales.

- A bank of criteria had been developed. The criteria were based on qualities suited to the study and practice of medicine, such as *Ability to work in a team, Ability to see from the perspective of others, Social responsibility, Recognising and responding to social diversity, Ethics, Coping with uncertainty* etc. After the criteria were selected each year the questions and rating scales were revised or developed by a committee of five. One new criterion was developed each year.

- The criteria *Commitment and motivation to study medicine* and *Communication skills* were assessed each year.

- The assessment of *Communication skills* was across four domains: Comprehension, Articulation, Relevancy and Interaction.

- The time allocation for an interview was 60 - 70 minutes, with the actual interview averaging 35 minutes and the remainder of the time being used for individual and consensus ratings.

8.2 Appendix B - Exemption from Ethics Letter

Our Ref: RA/4/1/7035

25 August 2014

Professor Sandra Carr
Faculty of Medicine, Dentistry and Health Sciences
MBDP: M501

Dear Professor Carr,

HUMAN RESEARCH ETHICS OFFICE – EXEMPTION FROM ETHICS REVIEW

Medical Student Selection Criteria & Their Influence on Demographic Characteristics & Academic Outcomes in a New Graduate Entry Medical Programme

Student(s): Andrew Junhan Lim

Based on the information you have provided to the Human Research Ethics Office (IHRO) in relation to the above project, the described activity has been assessed as exempt from ethics review at the University of Western Australia.

However, should there be any significant changes to the protocol, you must contact the IHRO to determine whether your exempt status remains valid or whether you will be required to submit an application for ethics approval.

If you have any queries please contact the IHRO at humanethics@uwa.edu.au.

Please ensure that you quote the file reference – RA/4/1/7035 – and the associated project title in all future correspondence.

Yours sincerely,

Dr Caixia Li
Manager, Human Ethics
### 8.3 Appendix C - Predictor variables vs Assessment Outcomes

#### 8.3.1 Foundations of Medical Practice

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