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Predictive value of University entrance tests in Medical Schools of Pakistan for academic and professional performance

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Predictive Value of University Entrance Tests in Medical Schools of Pakistan for Academic and Professional Performance

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Thesis certification

I, Shahid A. Akhund declare that this thesis, submitted as fulfilment of the requirement for the award of Doctor of philosophy, in the Graduate School of Medicine, University of Wollongong is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualification at any other academic institution.

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Contents

ABSTRACT

Introduction

There has been a great change in medicine and medical education both before and after 20th Century. The purpose of the changes was to better treat the diseases of the time. During different time periods before 20th century different nations in different parts of the world showed landmark changes in medicine (Spyros & Panagiotis, 1999). In medical education reform a report presented by Abraham Flexner could be considered as a landmark step (Munger, 1968). The context in which this report was produced still seems to be relevant and a model for world (Amin et al., 2010; Danforth, 1969). Besides six other recommendations Flexner emphasized the selection of appropriate candidates for health profession (Markel, 2010). While elaborating on improvement of the health care delivery in 20th century Frenk et al. (2010) also emphasised the redesigning of selection processes in medical schools.

One of the goals of medical schools is to select the students who will complete the medical education successfully and make a positive difference at national, international and global medicine (Kleshinski et al., 2009; Ramsbottom-Lucier, et al., 1995; Salem et al., 2013). The selection of appropriate health professionals who are not only intelligent but caring, passionate, motivated and having social values is becoming a difficult task (Wood, 2014). The selection process in medical schools is very selective, competitive and difficult (Arzuman et al., 2012). It is essential to investigate certain factors which predict the future academic performance of candidates (Haist et al., 2000). In early 1920s in the US a standardized test for selection was introduced and it was during this time several aptitude tests were developed (McGaghei, 2002). It was in 1983 that one of the private medical colleges in Pakistan started having entrance test (Rahbar et al., 2001). Currently the entrance test is a requirement in all medical colleges/universities of Pakistan.

Research question

As the compulsory use of entrance tests is a relatively new phenomenon in Pakistan it is imperative to evaluate the logical, psychometric and empirical evidence to justify their prominent role in selection processes in medical schools. The predictive

power of any process should show logical, psychometric and empirical consistency. The logical fitness of a process needs to be verified empirically by measuring its predictive power (van de Vliert, 1981). The measure of predictive power of any entrance test has been considered as the most important empirical evidence to justify the significance of the test in decision making.

Predictive validity is the power of a given test to anticipate the future measure of performance of a person on construct(s) of interest measured by the correlation between the performances measuring appropriate constructs. The weakness in correlation indicates that i.e the construct assessed by those two tests are different (Van der Vleutenet al., 1991). Educational measurement and psychometric analysis of test scores are used to make inferences. This has led validation exercises as an essential process in test evaluation (Streiner & Norman, 2008). The validity is the most significant measure while evaluating the worth of a given test (Mehrens, 1987). In order to interpret meaningfully assessments in medical education requires evidence of validity (Downing, 2003). The main research question raised in this study regarding the education value is: to what extent the entrance test and other component parts considered for admission in medical university or school predict the future cognitive performance of candidates.

Methodology

This study was conducted at public medical universities of Pakistan. The study is retrospective, quantitative and longitudinal in its design. The data sources were the official records showing students' preadmission information and assessment scores achieved during undergraduate medical education. Data of various predictor or independent variables and

outcome measures or dependent variables were collected. The data were analysed using Statistical Package for Social Sciences (SPSS) software. The academic achievement in Secondary School Certificate (SSC) grade X, Higher Secondary School Certificate (HSSC) grade XII, National Testing Services (NTS) entrance test, cumulative admission scores, basic sciences, clinical sciences and overall MBBS scores were compared across different groups of students based on sex, residential address, university attended and admission criteria. Later correlational and regression analyses were conducted to analyse the associations between different predictor and outcome variables. Also, regression analyses were performed to identify and measure the predictive power of various models of preadmission variables for the university entrance test achievement, basic science achievement, clinical science achievement and MBBS achievement as an undergraduate medical education performance outcome. In this study various parametric statistical tests, analysing the relationship between different variables, including *t* test, analysis of variance, regression analysis and Pearson correlation were used.

Main findings

The majority of students attend university located near an urban city. The average age of students is 18.17 years. The student intake from rural areas corresponds to the population distribution of the country. The performance of students coming from urban areas is only better in pre-university assessments including entrance test. The majority of students are female and their performance is better than male students. The entrance test scores have a weak positive correlation with the outcome variables. The school achievement especially HSSC science subject scores have strong positive correlation with outcome variables. A model of HSSC science subjects' scores, scores in HSSC language, SSC scores and male sex predicted the achievement in entrance test. A model of entrance test scores, admission in a university located close to an urban city, achievement in three science subjects and being resident of an urban area forms theoretically the most coherent model for predictive validity of future performance.

Conclusion

The average age of the student calculated was 18.17 years. Schripsema, et al, (2014) reported almost the same mean age 18.9 years of students. The gender composition of the study suggests that there are more female students than male students pursuing medicine as a profession. Keeping the definition of rural setting as suggested by Couper (2003) in mind, the urban-rural composition of the enrolled students studied points out a clear majority of 75.2% of students have a rural residential background. This composition reflects the rural settlement of the majority of population of Pakistan (Pakistan Bureau of Statistics, 2016).

The current study shows that the performance of female students is better than male students in SSC grade X assessment and HSSC grade XII assessment scores including all science and language subjects only. McManus, et al. (2003) and McManus, et al. (2013) reported the similar underperformance of male students in prior school attainment. In the entrance test achievement the difference between male and female students was not significant statistically. Koenig, et al. (1998) also reported a lack of difference between sexes in Medical College Admission Test (MCAT) achievement. The performance of female students during medical education has been statistically significantly higher than male students.

Kargic and Poturak (2014) emphasized the importance of selecting a university in student's life. In this study it is observed that the high achieving full fee-paying students choose NMC located near a rural settlement. This is in contrast with Bringula and Basa (2011) suggesting that a university located in the rural area faces more challenges of attracting students.

The scores achieved by students in entrance tests showed a decreasing trend across the years. Callahan et al. (2010a) also reported that there was no significant improvement in the validity coefficient of MCAT. The correlation provides the linkage between the previous and current achievements, (McManuset al., 2013) hence the correlations shows the predictive power of a test. As Donnon, et al. (2007) reported small to medium predictive validity coefficient for MCAT, this study found a small positive but significant correlation of entrance test with pre-clinical and clinical year achievements. Similarly UMAT also has a small correlation with performance in initial year of university studies (Wilkinson, et al., 2011).

This study also reports that there is medium but significant correlation between SSC achievement and basic and clinical sciences scores. Furthermore, HSSC scores calculated by addition of all science and language scores were better predictors of performance both in preclinical and clinical years. Also the correlation is better for clinical years than pre-clinical years. As McManus et al. (2003) reported that the later performance in medical schools is not only related to initial performance during medical education but also to the performance at school as well. This study adds that the inclusion of achievement in the language subjects improves the correlation further. The HSSC science subjects, language subjects' scores, SSC scores and male sex significantly predict the achievement scores in entrance test. Similar to basic and clinical sciences achievement the scores in university entrance test and HSSC science subjects' scores, along with being urban student at NMC predicted the best outcome variable of MBBS. McManus et al. (2003) and McManus, et al. (2013) also reported similar statistically significant results showing the previous school performance predict future performance in basic and clinical sciences assessment during medical education. This study also supports Shulruf, et al. (2012a) suggesting school achievement as strong positive predictor of performance in medical school achievement.

CHAPTER ONE

INTRODUCTION

The introduction chapter starts by presenting the background and context of the study. The foundation of the background section of the chapter is drawn mainly from the literature related to medical education reforms and selection of health professionals. The context section provides the relative details of reforms and selection process of medical students in public medical schools of Pakistan. The chapter ends by providing personal observations regarding the changes in medical education over the course of time and aim of the study.

BACKGROUND

There has been a great change in medicine and medical education which evolved from doctrine and dogmatic based expertise to the more scientific and methodical in its approaches following rules and principles in treating patients and teaching of medicine. The changes are observed both before and after 20th Century. The purpose of the changes was to better treat the diseases of the time. During different time periods before 20th century different nations in different parts of the world showed landmark changes in medicine (Spyros & Panagiotis, 1999). The use of technology in medicine has transformed the practice of medicine during the 20th century. In medical education reform a report presented by Abraham Flexner could be considered as a landmark step (Munger, 1968). The context in which this report was produced still seems to be relevant and a model for world (Amin et al., 2010; Danforth, 1969). Besides six other recommendations Flexner emphasised the selection of appropriate candidates for the health profession (Markel, 2010). While elaborating on improvement of the health care delivery in 20th century Frenk et al. (2010) also emphasised the redesigning of selection processes in medical schools.

One of the goals of medical schools is to select the students who will complete the medical education successfully and make a positive difference at national, international and global medicine (Kleshinski et al., 2009; Ramsbottom-Lucier et al., 1995; Salem et al., 2013). In health profession education the selection of appropriate health professionals who are not only intelligent but caring, passionate, motivated and having social values is becoming a difficult task (Wood, 2014). The selection process in medical schools is very selective, competitive and difficult (Arzuman et al., 2012). In order to supply the quality physicians, it is essential investigate certain factors which predict the future academic performance of candidates (Haist et al., 2000). The search for the best model that predicts the future successful performance of medical students resulting in improving the life of patients remains challenging (McLaughlin, 2012). The measures of success also vary among stakeholders in society and the health profession as highlighted by Shulruf et al. (2012a) and McLaughlin (2012).

In early 1920s in the US a standardized test for selection of health professionals was introduced and later similar tests were introduced in various other parts of the world. It was during this time several aptitude tests were developed (McGaghei, 2002). In different parts of the world currently various tests are used for the selection of medical students. The Medical College Admission Test (MCAT) is used in Canada and the US. Similarly, Australian medical schools use Graduate Australian Medical School Admission Test (GAMSAT) and in the United Kingdom, United Kingdom College Admission Test (UKCAT) is used. In Saudi Arabia candidates for the admission in medical programmes are required to sit for a College Aptitude Test (CAT). The Weill Cornell Medical College at Doha Qatar requires standardized tests (the SAT Reasoning Test or ACT with Writing and SAT subject tests in mathematics and two relevant sciences). The admission in the medical schools of Iran is solely based on the performance of candidates on Konkoor examination. The selection of medical students in Delhi is based on academic criteria in the form of a combined entrance test Delhi University Medical–Dental Entrance Test (DUMET). In Pakistan writing an entrance tests administered by National Testing Service (NTS) known as NTS entrance test is one of the prerequisites for admission to medical schools.

Predictive validity is the power of a given test to anticipate the future measure of performance of a person on construct(s) of interest. The predictive power is measured by the correlation between the performances measuring appropriate constructs. The weakness in correlation indicates the difference of constructs measured at two different occasions by two different tests. The weak correlation between the scores of two tests indicates that the construct assessed by those two tests are different (Van der Vleuten et al., 1991). Currently the test developers use educational measurement and psychometric analysis of test scores to make inferences. This intricate development of educational measurement and psychometric analysis has led validation exercises as an essential process in test evaluation (Streiner & Norman, 2008). The power of validity is the most significant measure while evaluating the worth of a given test (Mehrens, 1987). In order to meaningfully interpret assessments in medical education requires evidence of validity (Downing, 2003). The important aspects of test quality were highlighted by psychometric theorists, since the early 20th century, who also suggested means for validating tests. In addition, since the 1950s, formal guidelines are published for test developers and test users to clarify what validity is and how tests should be evaluated (Sireci & Parker, 2006).

In the wake of increasing cost of medical education and the social responsibility to produce competent doctors people engaged in the selection of medical students try to predict their academic success based on the cognitive, non-cognitive and demographic variables (Burch, 2009). Among the cognitive variables, prior academic performance and performance in admission test are used commonly. The academic success is commonly predicted by the prior academic performance. Including some other factors, a high matriculation score is the most influential predicting factor (Mills et al., 2009).

The demographic factors like age, sex, residential address, and marital status have been studied. In the validity studies of medical college admission tests the independent variables include performance measures such as medical licensing examination, clinical skills assessment, certifying examinations, professionalism evaluation and other competencies.

In the research related to selection of medical students for medical school using admission tests as standardized assessment tools for the entry into medical schools, MCAT is most widely studied. This is perhaps due to the fact that it was one of the initial tests used. Though it was not instituted to predict the future performance, most of the studies related to MCAT address its predictive power. Since its inception in 1928, MCAT has been revised five times. These revisions modified the structure and the content of the test (McGaghei, 2002; Petek & Todd, 1991).

The demographic variables however accurate, reliable and easily obtained are argued to be moderator variables rather than predictor variables (Nowacek & Sachs, 1990). A varied correlation of age and sex with success in pre admission and performance at medical schools is reported (Ramsbottom-Lucier et al., 1995). Although the role of age as a predictor has not been studied extensively, the younger applicants at the time of admission are considered to have issues related to their social interaction while older applicants might be challenged with study loads which affect their performance but the difference in performance is not significant (Friedman & Bakewell, 1980; Herman & Veloski, 1981). Haist et al. (2000) and Hesser and Lewis (1992) however reported that the younger students' performance is better than older students.

Like age, the sex of candidates also showed varied correlation with performance. Salem et al. (2013) described that in a medical schools located in the Middle East taking students representing a conservative society the sex of students is significantly associated with performance in medical school. Female students' performance is significantly higher than male students. Haist et al. (2000) stated that the difference in the performance of men and women depends on the settings of the performance assessments. They also report that the difference in performance of female students is attributed more to organisational structure than the abilities of academic performance.

Although it appears that demographic factors should not influence the selection, these play an important role in addressing the issue of health care delivery. For instance, the issue of shortage of doctors in rural and remote areas and lack of health care facilities to minorities and underprivileged low-socioeconomic population could not be addressed effectively unless a representative number of the candidates from these groups are not selected to pursue a career in health profession. There is a growing issue of shortage of rural doctors in Australia (Eley et al., 2007). Emery et al. (2009) evaluated a programme which highlighted the importance of recruitment of students from rural and remote areas of Western Australia. They highlighted the discrepancy of health workforce in urban and rural areas not only in Australia but also other parts of the world. The rural areas show a deficiency in work force. They emphasised the fact that medical graduates having a rural background are more likely to practice medicine in rural areas. Besides the rural and urban divide provision of health care services to minorities, underprivileged and low-socioeconomic populations is also an issue (Rumala & Cason, 2007). Multi-racial classes in medical schools are beneficial academically. However, students from similar background are more likely to service their communities (Mendes et al., 2014). Kneipp et al. (2014) underlined the role of social factors and interpersonal interactions in selection of a career by students. In a study based on a large scale survey in the UK, Hemsley-Brown (2015) also pointed that the candidates from disadvantaged back grounds are less likely to attend prestigious universities in the UK, even with similar grades and scores in schools attended before.

CONTEXT

From the time of independence, efforts were made to have similar entry requirements at Pakistan medical schools as those in United Kingdom (McGirr & Whitfield, 1965). Since the time of independence till early 1980, achievement in HSC Examination in science was the requirement for enrolment into medical colleges and strict merit was the order of selection. The inclusion and exclusion of selection interview was debated. The competition for enrolment has always been competitive. Only 20% to 30% of high achieving students can get admission in medical college (Afridi, 1962). Some variations in selection process were based on regional representation and allotments for female students. The regional variation was the basis of having a quota system in admission process in which certain number of seats was allocated to different geographical areas (Margulies, 1963)

It was in 1983 that one of the private medical colleges in Pakistan started using an entrance test for admission (Rahbar et al., 2001). Later the same phenomenon was observed in other private medical colleges. These entrance tests have both written component and interviews. Although many medical colleges are trying to improve the system of medical education at institutional level, the most obvious change every medical college has shown is in the student admission process. As per regulation of Pakistan Medical and Dental Council (PMDC) a centralised entrance test is mandatory for all medical colleges of Pakistan. These tests are to be designed and conducted by Provincial authority and National Testing Services (NTS). PMDC has further laid down guidelines regarding admission in medical and dental colleges of Pakistan. While determining the order of merit, PMDC has suggested 50% weightings for achievement in entrance test, 40% for higher secondary school education or equivalent and 10% for grade ten or equivalent achievement. PMDC has allowed institutional based interviews and aptitude test within the weightings of entrance test.

Admission Process

The minimum qualification for local students to be eligible to seek admission in Bachelor of Medicine, Bachelor of Surgery (MBBS) programme at medical schools in Pakistan is achieving at least grade B or 60% in HSSC examination in premedical group.

This pre-medical group of students take physics, chemistry and biology as mandatory subjects beside language subjects like English, Sindhi and Urdu in their HSSC examination. HSSC examination is offered by different public sector examination boards in Pakistan. Inter Board Committee of Chairmen (IBCC) is a regulatory body which recognises, scales and equates the examination results of the various examination bodies. The candidates who have taken school examinations with any examination board or body, other than public examination boards in Pakistan, are required to submit the equivalency of examination certificate issued by IBCC. The candidates who are permanent residents of various districts can apply under different admission categories: general merit, reciprocal meaning mutual exchange of students between two medical schools, disabled and local self-finance. There are a number of allocated seats for various districts.

Candidates who meet the requirement of grade B or 60% in HSSC examination are eligible to write the entrance test. The entrance test assesses the curricular contents of prescribed syllabus of various examination boards administering SSC and HSSC examinations in Pakistan. The test consists of 100 multiple choice questions with 30 MCQs each for biology, physics and chemistry, and 10 for English. Various versions of the same test are administered to avoid use of any unfair means during the test. Test is administered for 100 minutes. The candidates mark their answers on a multi-purpose computer marking answer sheet also known as Optical Mark Reader (OMR) sheet, and it is later scored by OMR scanner. Every correct answer is awarded +4 points and for every incorrect answer there is a penalty of -1 point. A sample of entrance test paper is attached (Appendix A).

The final merit score for admission is calculated by computing the scores achieved in SSC and HSSC examination and entrance test. Before computing final scores, HSSC examination scores are adjusted as follows. If a candidate proves that he or she has memorised Quran; additional marks are added. If a candidate has passed SSC or HSSC examination in a year before the prescribed year for admission, ten marks are subtracted for every year before application. The final merit score is computed by adding three different component scores according to following weightings:

A) SSC or equivalent 10%
B) HSSC or equivalent 40%
C) Entrance test 50%

The top score achieving candidates are offered the placement in medical school.

Before the academic intake in medical schools for 2007/08, HSSC scores were calculated from all HSSC subjects including biology, physics, chemistry, English and language (Urdu/Sindhi). Since year 2007/08, scores in three science subjects: biology, physics and chemistry are considered for computation.

The academic eligibility for international candidates includes scores in biology, chemistry and physics or mathematics. They have to have equivalence certificate from IBCC with minimum 60% achieved scores. They are also required to submit SAT-II examination score of minimum 700 and valid TOEFL or IELTS score of 500 or 5.5 respectively.

Curriculum design and assessment:

The undergraduate medical curriculum is governed by the rules and regulation of PMDC. It is a five year course that comprises of basic and clinical sciences subjects. Various subjects are taught in different academic years. While anatomy, biochemistry and physiology are taught in the initial two years of the course; pharmacology, pathology, community medicine, forensic medicine, Ear ,Nose and Throat surgery (ENT), ophthalmology, pediatrics, obstetrics and gynecology, medicine and surgery are taught in the later three years of MBBS course. The teaching methodology includes small group teaching and learning sessions, large class lectures, laboratory practical and experimentation, community field visits and out-patient and in- patient clinical teaching. The assessment methods include MCQs and short and long essay questions to test knowledge, and Objective Structured Practical Examination (OSPE), Objective Structured Clinical Examination (OSCE) and viva voce to test practical and clinical skills including professional behaviour and competencies.

Since the intake of students in year 2007/08, curriculum delivery method was changed from one-year long academic session to a sixteen-week semester system. This new academic organisational and administrative change did not affect the curriculum content but impact assessment. Unlike taking end-of-the-year professional examination before, currently students write end-of-semester examination only. The end of the year examination score is however computed for each student by adding the scores achieved in different subjects assessed in two semesters of the year. Table 1.1outlines the structure of curriculum organization.

As a physician and academic having a lived experience in the field of medical education in Pakistan, I have observed several changes which were introduced during various times. The main driving force for these changes is the essential reforms in medical education required to address the issue of poor health care delivery system. Emanating from the reform agenda, the introduction of entrance tests as one of the criteria is the most significant change in the selection of students in medical schools. The selection of medical students and the composition of health professional work force needed to address the poor health care delivery are closely related. There are many new private and public medical colleges in various rural and urban areas of Pakistan. As a result of increase in the country's population size, the number of students aspiring to get in the medical profession is also increasing. Consequently, the admission in the medical schools now is becoming even more competitive. Before the new selection criterion was implemented, students used to focus more on their school education and tried to achieve good grades to enter in a medical school. Nowadays students not only have to prepare themselves for school education but have to struggle through an additional requirement of entrance test for getting into a medical school. The high schools teach only prescribed syllabi for grade ten and twelve and do not prepare students for writing different entrance tests.

Table 1.1Curriculum Organization in public medical schools of Pakistan.

	Before 2007/08		After 2007/08	
Subjects	Taught in year	Assessed	Taught in semester	Assessed in semester
Anatomy, Biochemistry and Physiology	1st	1st Year MBBS Professional examination	1st and 2nd	1st and 2nd
Anatomy, Biochemistry and Physiology	2nd	2nd Year MBBS Professional examination	3rd and 4th	3rd and 4th
Pharmacology and Therapeutics, Forensic Medicine, General Pathology	3rd	3rd Year MBBS Professional Examination	5th and 6th	5th and 6th

Special Pathology, Community Medicine, Ophthalmology and ENT	4th	4th Year MBBS Professional Examination	7th and 8th	7th and 8th
Ob and Gyn, Pediatrics, Medicine and Surgery	5th	5th Year MBBS Professional Examination	9th and 10th	9th and 10th

As an effect, an increase in the number of private coaching institutes is observed especially in the urban areas. These institutes prepare students for writing entrance tests required for different educational programs including medicine. It is seen as an additional financial and educational stress on students and parents.

The curriculum in medical schools changed from conventionally organised preclinical and clinical years with an annual exam at the end of the academic year to integrated curriculum with half yearly examinations and early exposure to patients. Earlier, the initial two years of medical curriculum used to focus on anatomy, physiology and biochemistry only. Now in addition to those subjects, pathology, pharmacology and community medicine is also incorporated in initial two years of curriculum. Teaching was more in the form of lectures, small group tutorials and laboratory session in initial two years and in-patient teaching in the affiliated clinics and hospitals. Now in addition to lectures, tutorial and lab session, problem based or case based learning session; blended learning approaches are becoming popular mode of teaching. End of the year examination comprised of long descriptive essays and oral examinations for basic sciences, and long essays and clinical competencies assessment on real patients. Now the assessments had a different format of MCQs, OSPEs and structured short essay questions (SEQs) for initial two years and MCQs, SEQs, OSCEs on real or simulated patients for clinical years to assess clinical competencies. All these changes were made as legislative requirements for the accreditation, but the academic values of these changes are rarely analysed.

There is a lack of local contextual evidence to support the changes in medical education and this is the rationale of this study. This lack is more severe in public medical school context as compared to private medical schools. Among the changes made in medical education in Pakistan, the inclusion of achievement in entrance test in the selection criteria for admission in medical schools is of great interest to many academics. The test is widely used but less thoroughly studied, especially in the public medical schools setting. It is not known empirically whether the inclusion of entrance test achievement in the decision making process of selection is appropriate or not. Hence if the test provides any further information to decision makers is not known. The focus of this study is to investigate the academic importance of prior academic achievement and entrance test scores used in the decision making for selection. The scope of this proposed study is to investigate the predictive validity of entrance tests in predicting the academic performance of students in public medical schools of Pakistan. It will also investigate the differences in performance between different groups of students based on sex, residential location, admission scheme, location of medical school and year of enrolment. The data from public medical schools will be collected and the parametric statistical tests will be used to analyse the data. This study will not investigate the assessments tools used.

The outcome of this study is aimed to provide scholarly information to people involved in the selection process, candidates and community regarding the utility of entrance tests in Pakistan. Regarding entrance test there is knowledge niche for this this part of the world. This study would add in the relevant literature and inform the academic body regarding use of entrance test conducted in the context of a developing country undergoing reforms in medical education.

The thesis is organised in five chapters starting with introduction, literature and research question, methods, result and discussion chapter with concluding remarks.

CHAPTER TWO

LITERATURE

The history of health and disease is as old as history of human kind. With the time and changing world demographics and environment the pattern of diseases has also changed. Similarly, the understanding of underlying principles and methods to ensure health and treat disease has also evolved. The clinical practice evolved from having intuitive basis to more scientific and technological support. Over the course of time medicine and medical education has shown advances. For the purpose of this proposed study, a brief historical account is shared. This will help in defining the links of healthcare reforms and medical education. The understanding and exploration of selection of medical students and empirical significance of tools used will be the focus of this study.

Medical education reform before 20th century

The battle between man and disease has continued since the origin of man. The manner in which prehistoric, palaeolithic, mesolithic and neolithic man dealt with diseases is known to them only. It is the Hellenic Civilizations which are recognized as being the seat of many scientific endeavours including medicine (Christos, 2009). Primitive man was concerned more with cure of the disease than its causes and natural course (Cohen, 1953). In the recognised history of medicine from the time of Sumerians and Babylonia to Hippocrates to after the dark ages in Europe and until the turn of twentieth century, the medical profession has shown great advances and reforms. These improvements were made in understanding, treating and preventing the diseases both at individual and community level, through scientific and technological advancements.

Initially, the basis of diseases was explained through different doctrines and dogmas.These formed the dogmatic school of thoughts. These were also influenced by different religious and cultural practices including spiritual healing, witch-doctors and priest-physician. Later the empiricists, as opposed to dogmatists, emphasised the observation. Empiricists were followed by Methodic school, who felt understanding the underlying problem was not necessary and described any knowledge before them as inaccurate (Libby, 1922).

Hippocrates, considered the father of medicine (Christos, 2009), became famous through his writings and those of Galen, and more so after Renaissance when the ancient

Greek medical writings were rediscovered (Spyros & Panagiotis, 1999). Hippocrates' conceptualization of the theory of four humours as basis of disease and consideration of patient as whole, dominated medicine for centuries. The post Renaissance period showed greatest improvement in scientific medicine.

While the Greek contributions in the field of medicine are much recognised, the contributions by Chinese, Indian, and Muslim scholars is equally significant. The *Kitab al-Hawi fi al-tibb* (The Comprehensive Book on Medicine) by Abu Bakr Muhmad ibn Zakar Tya al-Razi (865-925) was a standard reference book in Medieval Europe. Abu 'AH al-Husaynibn 'Abd Allah ibnSlna (980-1037) an authority on Islamic (Greco-Arabic) medicine wrote *Kitab al-Qanunft al-tibb*or *Canon of Medicine* which influenced medical practices in both medieval Europe and India (Subbaryappa, 2001). Such developments made Baghdad a seat of learning which influenced medicine in Europe.

After the time of the ancient Greeks, the other landmark in the history of medicine is the Renaissance. During this time the medical knowledge enriched and tried to explain the structure and function of human body (Spyros & Panagiotis, 1999). Europe by the end of the eleventh century, witnessed the establishment of first medical school at Salerno, the mother of medical schools. It put theoretical foundation to many scientific questions, compiled a manual of principles and processes of medicine. It intertwined the theory and practice in medical education (Medicine). The foundation of universities in Europe was also influenced by Salernitan school (Porter, 1996). As compared to 11th century medical universities which were more into theory development, 12th century universities showed similarities with Empiricist schools which relied on observation of human body in order to understand and treat the diseases (Porter, 1997).

Medical education reform and 20th century

The 20thcentury is marked by an explosion of scientific knowledge and technology which affected every walk of life including medical practice. This advancement of scientific knowledge has arguably reduced the abilities of medical personnel to apply the benefits to the general population. They have started relying more on the technological and less on humanistic approaches. The present day crisis of health care delivery could be linked with the effects of fast developing technical knowledge and clinical sub-specialization (Dillon, 1970). At the turn of 20thcentury another landmark in modern medicine is a report presented by Abraham Flexner (Munger, 1968). This report changed the whole spectrum of medical education and influenced almost every medical school. The Flexner report was the last major change in medical education; however medical schools and institutions also made changes in their curricula to keep pace with scientific developments (Hoover, 2005).The Flexner report is most cited but not fully understood report regarding medical education reform in the world (Ludmerer, 2010). The scope of Flexner's report is broad and it does not only stress on the education of physician in restricted curricular sense but also encompass the social and moral role that a physician has to play in the society as an educated man [person] (Dillon, 1970).

In America during late 19^{th} and early 20^{th} centuries there were hundreds of medical schools (Barkin et al, 2010). The standard of medical education in those schools was very low and questionable. Medical education during that time was a commercial enterprise with proprietary schools (Halperin, et al., 2010) producing ill-trained physicians (Johnson & Green, 2010). During that time one could essentially buy a medical degree without having any experience of medical school. To enter in medical school one did not need a high school diploma. The teaching was more like listening to practitioner's personal experiences, without having self-experience. It was not essential to have laboratories, anatomy classes or classes for other basic sciences (Diller, 2010). The lecture rooms were small with no laboratory experimentation or patient contact (Halperin et al., 2010). There were few clinicians for teaching and even fewer for basic sciences (Weissmann, 2008). The medical education system at that time was apprenticeship, proprietary or university (Halperin et al., 2010). These systems differed in their aims and objectives, teaching methodology and control mechanisms. Students trained by attachment with a practitioner, attending some course work or a combination of didactic teaching and clinical experience. Hence, the best and bright students travelled for better medical education to different parts of Europe (Ludmerer, 2010).

The American Medical Association (AMA) questioned the value of medical schools and their curricula. Academic medicine at that time was not regulated, causing a great disparity in qualifications for practice. In 1901, the AMA raised concerns about the quality of medical care and medical education. AMA initially formed the Council on Medical Education (CME) to evaluate the medical education. The CME presented its findings. To independently validate the findings, the AMA commissioned The Carnegie Foundation for the Advancement of Teaching to conduct a review. The Foundation selected Abraham Flexner for the task. To Flexner the medical schools at Johns Hopkins and Harvard were role models of medical education. These were similar to leading German medical schools of the day (Diller, 2010; Hunt, 1993). Flexner's model was to have the medical sciences based on scientific observations not mysteries (Hoover, 2005) and analytical reasoning skills as the core of medical education and practice (Cooke et al., 2006). Keeping Johns Hopkins as the standard, Flexner evaluated 155 American and Canadian medical schools. His criteria to evaluate any medical school were to observe five major areas before making his conclusion about a medical school. The five areas were entrance requirements, number of teaching faculty members and their development, financial sustainability of institution through different sources, the quality of experimental laboratories for first-two years of curriculum and affiliation of medical school with any hospital (Munger, 1968).

The Flexner report for reforms was a reaction against the weaknesses of a system or a non-system in medical education in America and Canada (Mann, 1976). While his report was majestic and herculean on one hand and equally criticized on the other, his personality was fascinating and controversial as well. Not surprisingly, both Abraham Flexner and his report were every bit as fascinating and controversial. He was a talented and ambitious man who promoted motivation as well as rivalry with his siblings. In 1884 he matriculated from the Johns Hopkins University. Poor but dedicated he completed his bachelor's degree in classics within 2 years. He became a public high school teacher and later founded his own experimental school having no formal curriculum, examinations, or grades and was dedicated to help each student regardless of ability to find his true potential. He was married to his former pupil. He was ambitious yet frustrated. He did master degree in psychology at the age of 39. He had a restless mind. He took various courses in different institutes in Germany. During this time he wrote about the failures of American higher education. His eagle eye and pointed pen made him also write about other topics like prostitution and produced a special report on Johns Hopkins Medical School. He was sensitive to the influence and authority in universities and foundations. Away from the public he was rarely humble. He could even be impolite as well as impatient, blunt and bitterly critical. However his criticism was born out of great respect for the education and institutions. Flexner's advice is considered as dogmatic, if not overreaching. He never had a formal medical training but his reputation as a judge of the quality of medical schools shows his motivation, rigidity and success (King, 1984; Markel, 2010). Nonetheless, he left behind a legacy of excellence and an educational system which has been a model for the world (Danforth, 1969).

The Flexner report was the last major change in medical education, to an extreme of making low standard medical schools shut in order to improve medical education. The underlying principles of Flexner's report are related to medical positivism, rigorous selection, scientific method of thinking, problem solving skills, experiential learning and original investigation (Ludmerer, 2010). Flexner's report has seven major recommendations summarised by Barzansky and Gevitz, 1992 cited in Johnson and Green (2010) as:

1. To reduce the number of poorly trained physicians;
2. To reduce the number of medical schools from 155 to 31 (by the time the report was published schools had already decreased to 131);
3. To increase the prerequisites to enter medical training;
4. To train physicians to practice in a scientific manner;
5. To engage the faculty in research;
6. To have medical schools control clinical instruction in hospitals; and
7. To strengthen state regulation of medical licensure.

The important features of recommendations, emphasized by Markel (2010), to which the medical school of 21st century should pay attention are adequacy of preparation (both human and physical resources), linkage with a teaching hospital, selection of candidates with higher order of qualification and engagement in original research. Highlighting the importance of selection of medical students, Flexner classified the medical schools based on the selection processes (Mann, 1976). The three classes of medical schools based on those that required: i) two or more years of college for admission, ii) a high school education or its equivalent and iii) no admissions criteria. Based on this as a starting point, he elaborated the characteristics of medical colleges. The CME during its first annual conference, to promote restructuring of USA medical education, highlighted the standardization of entry requirements in medical schools, as one of its recommendation (Beck, 2004).

Medical education appears to be in the state of constant change. It has arguably changed its focus to biology, clinical reasoning and development of the practical skills, character, compassion and integrity to scientific knowledge (Cooke et al., 2006). Flexner's report appeared applicable at different times during the last century (Amin et al., 2010; Danforth, 1969; Diller, 2010; Mindrum, 2006; Saidi, 2007). At the present time the relevance of Flexner's report develops even further as the health care reforms are closely linked with medical education and other issues like financing of health care and have a mutual interdependency (Deckers, 2000; Rafei, 1996).

While debating the reform in medical education and health care delivery, there arise certain questions which need to be answered. These questions are relevant in preparing the physicians for 21st century. These questions are related to imparting knowledge, skills, and values. Some of these questions are easy to answer, but others are more complex. Today the resources needed to meet the needs of health care delivery are limited.

While the science underpinning the medicine has transformed, medical education in Pakistan has ossified curricular structures which focus on the factual minutiae of knowledge, distracted and overcommitted teaching faculty and archaic assessment practices, and regulatory constraints abound (Nasim, 2011). These challenges slow the process of formation of knowledgeable, inquisitive minded compassionate and value bound physician (Cooke et al., 2006).

Health care reform is closely linked with heath professional education. This education needs to change from more dialectic to transformational mode of educational system. In such a system, the educational reforms, meant to serve the community, need to take place from admission process to graduation of medical students. In order to have positive effects of health care system on health outcomes of patients and populations, medical schools need to redesign their selection process as the first step in instructional redesign (Frenk et al., 2010). Frenk et al. (2010) emphasised the inclusion of both achievement and adscription variables in the selection process, because it is the mismatch between the possessed attributes of candidates and those required by patients and population which leads to poor health care delivery. They have linked the admission process closely with the institutional purpose, whether these are for admitting the best and brightest or for advancing health equity by proactive admission process.

The centrality of selection process is obvious in the debate of health care delivery and health profession education systems. The predicted outcomes of both systems could not be achieved without having an authentic selection process of medical students who will form the mainsail of human resource needed for the operation of systems. Many of the traits and skills which are expected to be observed in a physician could not be developed *de novo*, these are expected to be there in candidates aspiring as physicians serving the people and populations (Frenk et al., 2010). The selection process in medical schools is very selective, competitive and difficult (Arzuman et al., 2012).

Medical Education in Pakistan.

Pakistan was founded in August 1947, after gaining independence from its British rulers, by dividing India. It had two geographical constituencies i.e., East and West Pakistan. In 1971, East and West Pakistan were declared as separate countries and named as Bangladesh and Pakistan. At the time of independence the population of West Pakistan was 72 million, which in 2010 had grown more than twice to reach 166.52 million (Statistics, 2010).

In the country at the time of independence, King Edward Medical College at Lahore, established in 1860 was the only medical college with a capacity to produce only 62 doctors a year. It was too small a number of doctors to cater the needs of a vast country (Margulies, 1963).This shortage of doctors was aggravated by the mass migration of non-Muslim doctors to India, leaving less than a thousand registered medical practitioners. Providing more doctors for health care especially in rural areas was the immediate problem faced by Pakistan (McGirr & Whitfield, 1965). To deal with the situation, there was an expansion in number of medical colleges in Pakistan as well as increasing the rates of admission. One year after independence, Dow Medical College was established in Karachi, later Fatimah Jinnah Medical College for women at Lahore, Nishtar Medical College at Multan, Liaquat Medical College at Hyderabad (Sind) and Khyber Medical College at Peshawar were established (McGirr & Whitfield, 1965). In the first decade after independence, eight additional medical colleges were established. This led to rapid expansion of undergraduate medical education resulting in an annual increase of medical graduates from 100 in 1948 to 684 in 1960 (Afridi, 1962). The doctor-population ratio was 1: 20,000 in 1947 and in 1965 it was 1: 9600. This was due to increased intake of medial students and increase in number of medical colleges in Pakistan (McGirr & Whitfield, 1965).

Currently with an explosion in population size a dearth of available physicians is a serious issue. The increase in number of medical colleges is only a part of solution. The current ratio of 0.473 physicians to 1,000 population is inadequate to maintain the nation's health and in near future the physician work force shortage will be a serious issue for Pakistan. Currently, despite the dearth of resources the number of medical colleges is increasing (Talati & Pappas, 2006). In Pakistan, currently there are 127 recognised medical and dental colleges with 49 public and 78 private (PMDC www.pmdc.org.pk/Statistics). Most of the newly established medical colleges are located in urban locations of Pakistan.

Some of these medical colleges have been recently upgraded to the rank of a medical university. University of Health Sciences established in 2002, having 50 medical and paramedical affiliated institutes (Khan et al., 2009) exemplifies the current scenario of medical education in Pakistan.

Until 1963 all but one medical college were public (Margulies, 1963). In the face of shortage of physician work force, medicine as a lucrative career and availability of fee paying students many new medical colleges are established. Most of these medical colleges are profit-oriented. While in 1983 there was only one private medical college, by 2006 it reached to 18 (Talati & Pappas, 2006) and currently there are 78 private medical colleges in Pakistan. This is perhaps a reflection of political and economic structure of an underdeveloped country (Afridi, 1962), where public sector could not spend appropriate amount of its annual budget on health sector and leave it for private sector investments (Nasim, 2011).

In undivided India, the British Colonial services developed medicine (Margulies, 1963). The legacy of British rulers, in the form of medical curriculum followed, is still visible in many medical colleges of Pakistan. With time, however, the medical curriculum has shown changes in its content and delivery, but it is not unusual to observe the effects of colonization in the medical education reforms in the developing countries (Jen-Yu et al., 2012). Still, the conventional model of initial two years for basic sciences and later three years of clinical instruction is followed in almost all medical colleges of Pakistan. Most teaching is by lectures and some laboratory experience. These are overcrowded and not conducive for active learning. Clinical teaching is conventional bedside method carried out by senior clinicians. The process of assessment and its outcomes does not bear much educational value (Margulies, 1963).

In summer of 1962 a meeting was held at the Postgraduate Medical Center Karachi, to discuss the questions regarding curriculum, teaching, research and other similar problems of interest related to medical education (Margulies, 1963). In order to standardize medial education in Pakistan, PMDC was established in 1962. The undergraduate medical education objectives laid down by PMDC emphasised production of a compassionate, community-oriented general practitioner who manages health problems in a manner which is scientific and cost effective while using technology and a holistic approach. Furthermore, the doctor should also have leadership qualities with communication skills and a positive work ethic (Baig et al., 2006).

Since the beginning of medical education in Pakistan, the availability of teaching and learning resources has been an issue (Margulies, 1963).The lack of staff and equipment were a serious issue especially when establishing a new medical college. This was more pronounced in hospital laboratories. Not having an affiliated teaching hospital posed another difficulty in establishing a new medical college (McGirr & Whitfield, 1965). In the current state of increased number of medical colleges in Pakistan, lack of resources and affiliated teaching hospital is posing a greater risk of producing ill trained doctors (Shamim, 2003).The lack of resources is a chronic issue in delivery of medical education in Pakistan and has seriously affected the quality of medical education (Nasim, 2011).

From the time of independence, efforts were made to have similar entry requirements at Pakistan medical schools as those in United Kingdom (McGirr & Whitfield, 1965). Since the time of independence till early 1980, achievement in Higher Secondary Examination in science was the requirement for enrolment into medical colleges and strict merit was the order of selection. The inclusion and exclusion of selection interview was debated (Afridi, 1962). Some variations in selection process were based on regional representation and allotments for female students. The competition for enrolment was never easy to the extent that not all students with higher grades could be admitted (Margulies, 1963). The regional variation was the basis of having a quota system in admission process in which certain number of seats was allocated to different geographical areas.

It was in 1983 that one of the private medical colleges in Pakistan started having entrance test for admission. Later the same phenomenon was observed in other private medical colleges. These entrance tests have both written component and interviews. Although many medical colleges are trying to improve the system of medical education at institutional level, the most obvious change every medical college has shown is in the student admission process. As per regulation of PMDC a centralised entrance test is mandatory for all medical colleges of Pakistan. These tests are to be designed and conducted by Provincial authority and National Testing Services. PMDC has further laid down guidelines regarding admission in medical and dental colleges of Pakistan. While determining the order of merit, PMDC has suggested 50% weightings for achievement in entrance test, 40% for higher secondary school education or equivalent and 10% for grade ten or equivalent achievement. PMDC has allowed institutional based interviews and aptitude test within the weightings of entrance test.

Selection of the university and importance of rural health

In the view of financial issues faced by public universities of Pakistan, the universities have started enrolling students as private tuition fee paying students i.e. self-financing scheme of admission. A study by Bringula and Basa (2011), looking for the factors which determine the choice of students for certain universities, highlighted the issue of lack of resources in universities. They described that inadequate finances is a growing issue in universities especially those of the third world. In order to address the issue universities have increased students enrolments and started relying on the tuition fees for financial sustainability. Higher education institutions around the globe face a paucity of funds (Briggs & Wilson, 2007; Salmi, 1992). In the 21st century, this paucity of funds threatens the academic future and competitive edge of the universities (Gill & Gill, 2000).

Candidates aspiring for the medical education in Pakistan are selected on the basis of high pre-university attainment or they have the option of enrolment as full fee paying private student. There is a district wise quota of students in the public universities. However, students applying as full fee paying students can choose from the different universities of the region. The universities are located in both in metropolitan and non-metropolitan areas of Pakistan. Kargic and Poturak (2014) emphasized the importance of selecting a university in student's life. Young people aspiring for the future, look for institutions which provide them distinctive educational knowledge and experience. Many factors influence the selection of a university. They highlighted the role of culture, high school grades, parents' opinion and payments [tuition fees], career possibilities, study prestige. Also when choosing a university, the reputation of the university and the city in which it is located were ranked highly as factor which influence the selection of university. Bringula (2012) also concluded that proximity and accessibility alone or in combination influence the choice of educational institution.

Elacqua et al. (2006) highlighted the importance of choosing the educational institution and discussed the benefits and problems of the process. They reported that the choice is based on socioeconomic class more than the classroom. According to Bringula and Basa (2011) a university located in the rural area faces more challenges of attracting students. Briggs and Wilson (2007) concluded that the students are also becoming more considered when making decisions regarding choosing a university and for them it is not a simple linear process. They confirm that the educational cost plays a less important role than other factors in choosing a university. They suggested, however that the lesser role of cost in choosing a university is not an informed perception of the students. The inadequate information search by students is also documented (Tatar & Oktay, 2006). Pimpa and Suwannapirom (2008) revealed the attractiveness of the campus and tuition fees as important factors which influence the students' choice of educational institutions. Bahry et al. (2013) also showed that reputation of the university and learning environment influence the selection of a university.

While analysing the impact of choosing a school Burgess et al. (2007) mentioned that this phenomenon, having an economic argument, create winners and losers, and the choice of place of study is also influenced by peers. In this economical and consumer- oriented higher education there has been a shift in its governance (Hemsley-Brown & Oplatka, 2006). To be successful in this competitive educational environment institutions should have strong marketing strategies which help them disseminate the quantity and quality of information regarding the institution to attract prospective students (Briggs & Wilson, 2007).

Abubakar et al. (2010) reported that students do change their choices in selecting an educational institution, and emphasised the role of marketing of service as something which defines the selection of a particular institution. To attract a diverse body of students there has been an increase in the competition between institutions. The competition is to attract both domestic and international students.

The international focus on addressing the problem of serving the communities of the world is reflected from the WHO recommendation in 2010 based on consultation paper by Dolea et al. (2009). The recommendations included recruitment of candidates with rural background, building medical schools outside the major cities, increased interaction of students with rural communities and incorporating the health needs of rural communities in medical curricula accordingly (Yi et al., 2015). While creating the medical work force due care should be paid to the selection tools used because selection is the first crucial step in developing general practice workforce. In Australia and New Zealand the utility of UMAT is seen as low for predicting future performance, a low score in UMAT best predicted the interest in general practice (Poole & Shulruf, 2013). This low score predicating a strong interest in the general practice draws attention towards high cut off values and the loss of a workforce that might be interested in the general practice to serve the communities through primary health care facility.

The importance of serving the health care needs of rural and remote communities in medical curricula and health care system is more than obvious now (Couper, 2003; Maley et al., 2009; Snadden, 2011). As a social responsibility medical schools should address the issues of inequalities of health care for the communities particularly those in underserved areas. Educating the rural students is one of the measures which is assumed to address the issues (Yang & Richardson, 2013). It is proposed that rural students are more likely to practice in remote areas. Snadden (2011) emphasized the selection of medical students from rural areas as they are most suitable to address the issue. Although in the health care paradigm the definition and understanding of rural and urban areas is challenging, one of the definitions of rural area suggested by Couper (2003) seems appropriate. He proposed "the rural areas are those outside of metropolitan centres where there is not ready access to specialist, intensive and/or high technology care, and where resources, both human and material, are lacking" (pg2).

Medical College Admission Test

Individuals involved in the selection process of medical students, especially those in public medical schools, have a greater responsibility to make the best use of resources including the admission data available to them. The question of whether the effective impact on the quantity and quality of patients' life could be predicted from the initial admission data remains unanswered. Therefore the search for a successful model of student selection in medical school remains an ongoing process. It's like driving in the fog where one can only see for short distances. Similarly predicting from admission data the future clinical performance with any accuracy remains difficult (McLaughlin, 2012).

In relation to the selection process of the medical students, Shulruf et al. (2012a) questioned the success of students measured by the significant and quantifiable outcomes like decrease in the drop out ratio and achievement scores. However, for the society a significant outcome would be the patient care by physicians after they have gone through a residency training programme. Hence, the success of admission processes should not only be measured by reduced dropout rates only but should also include the production of graduates who can serve society's current and future health care needs effectively. From pragmatic point of view, McLaughlin (2012) suggested the completion of initial years of medical education without dropouts as a significant outcome for the selection committees. The later successes are joint responsibilities of students, medical school and residency training programme.

The society needs to be served by good doctors, but the definition and characteristics of a good doctor is changing. The change in conceptualizing the characteristics of a good doctor is influenced not only by historical construct but also by modern social values. The shift in the characteristics from being scientist and man of character in the 20th century to a person competent in certain roles and domains is more than obvious in 21st century. This change in discourse has direct implication for medical educators not only in designing the curricula but also in the complex process of the selection of students for the medical profession (Whitehead et al., 2013).

In rapidly expanding and changing medical science knowledge and technologies, curricular changes in medical education are essential. These changes are aimed at preparing medical students for practice that is well aligned with varying demands of the society and requirements profession itself. While the knowledge of basic science concepts is a requirement, it does not predict success in medical school (Wiley & Koenig, 1996). In today's world, tomorrow's doctors are expected to be competent in managing data, solving scientific and clinical problems, acquiring lifelong learning skills and communicating effectively with diverse stakeholders. Medical schools are thus not only revising their medical curricula but also instituting selection processes designed to identify students capable of developing and using afore mentioned competencies (Mitchell et al, 1994). It was perhaps the mismatch between required and possessed competencies of medical students which results in attrition at medical schools.

In early decades of 20th century, the attrition rate of medical student was 5% to 50% (McGaghei, 2002). High levels were considered to be due to selection of students lacking appropriate aptitude for medicine. Hence, the resultant waste of resources and loss of aspirations was obvious. Standardised medical college admission tests as a part of entrance requirements started some hundred years ago. It started in medical colleges of United States as early as the 1920s. Later similar process was observed in Canada, United Kingdom, Europe, Australia and other parts of the world including various countries in Asia. Among various medical college admission tests offered world wise, MCAT in the US is most intensively studied for its educational merits. During post Flexner Report period many changes and innovations were introduced in medical education at the United States medical colleges. Based on recommendation by Flexner, the admission processes in medical colleges were revamped in order to recruit suitable candidates for medical profession.

In 1920s some medical colleges in the US used objective standardized tests for recruiting medical students. Later the American Association of Medical Colleges sponsored a nationwide test for selection of medical students (Erdmann et al , 1971). It was during this time that scientific psychology and quantitative approaches to mental measurement were on the rise and several achievement tests were developed. Scholastic aptitude and academic achievement of different individuals were linked and measured through scores achieved on a given test (McGaghei, 2002). Over the course of time, different test developing agencies used various forms and names for the test, however the main design of the test paralleled to the type of learning required in medical schools and future physician. MCAT is used in Canada and the US. Similarly, Australian medical schools use GAMSAT and in the United Kingdom, UKCAT is used.

Since its development in 1928 MCAT has been revised five times. In its first version, there were 6-8 subsets of the test which focused on memory, knowledge of scientific terminology, reading and comprehension, and logic. In 1946 the second version was published. It had four sections: verbal and quantitative skills, science knowledge and understanding of modern society. In 1962, the third version had only one major change of focus from modern society section to general information. In 1977 expansion of science section, reading and quantitative skills, and elimination of liberal arts knowledge section were observed in its fourth version. During the same time its scoring system and format were also revised. Later in 1991 the fifth version of MCAT was introduced in order to enhance content relevance, reduce cultural and social influence on performance, and improve comparability of measures of achievement in sciences. This version included Science Problem Solving (a composite score derived from the Biology, Chemistry, and Physics subtests), Quantitative Skills, and Reading Skills. The latest version of the MCAT, administered since 1991, consists of the following four subtests: Biological Sciences, Physical Sciences, Verbal Reasoning, and Writing Sample. The writing sample section is the principle innovation in the current version. MCAT over its various versions showed the link between social and professional mores and values with understanding of aptitude for medical education (Callahan et al., 2010a; McGaghei, 2002).

While candidates take entrance test to get in to the medical universities of Pakistan, not all achieve the required cut-off scores to be enrolled on the basis of merit criteria scheme. However, the same entrance test scores are used for self-financing admission scheme. While describing the processes of selection and use of UKCAT scores in the selection of students in medical schools in the UK; Adam et al. (2011) noted the assessment of academic qualification as the first step. They pointed out that there are different methods in which the UKCAT scores are used by different medical schools in order to make the selection process as fair and broaden the participation of students. They concluded that more than one method of using UKCAT score is observed in many medical schools in the UK. While the UKCAT is used in the UK University Medical schools, the correlation of UKCAT achievement with candidates' performance in the university selection process is weak (Fernando et al, 2009).

Two of the important criteria of a good assessment are that the tests should be fair and un-biased. A fair and un-biased test should not favour one group more than the other group of students based on background variables. Emery et al (2011) suggested that the admission tests should not only have the predictive power but also show fairness by being un-biased. They determined the fairness of BioMedical Admissions Test (BMAT) for medical student selection, by measuring the predictive power of scores achieved for future examination performance, to suggest whether the test predicted equitably or not.Traditionally the admission in medical schools was based on prior attainment at schools and interviews. They investigated the issue of fairness in the light of growing number of suitable applicants having higher grades in school assessments applying for medical schools. While medical schools are widening student participation, an admission test would be regarded as unfair if it shows bias towards a particular socio-economical class, gender, ethnicity or any other background characteristic of the candidates.

Although it sounds like that the entrance tests in medical schools have only academic purposes they also serve as barrier to limit the number of students. The medical universities in Austria introduced a knowledge test in 2005 after a court order to limit the number of students entering in the human medicine programme (Reibnegger et al., 2010). This test was introduced as a measure to handle the large number of students, admitted based on school achievements only, beyond the managing capacities of the institution resulting in large number of dropouts and prolongation of the academic programme. After the introduction of the test, the success rate of completing the initial courses and reduction in dropouts were dramatic. Shulruf et al (2012b) also pointed out the possible use of admission criteria to reduce the dropout rates. They also emphasised the alignment of admission criteria with the medical curricula in order to produce medical graduates who can serve the needs of society now and in future. The BMAT in the UK was also designed in the face of more applicants than places issue (Emery & Bell, 2009).

Test Validity

The theoretical framework of the analysis in the current study is inspired from "The Academic Backbone Model" presented by McManuset al. (2013). In this model during the medical education journey, current learning and achievement is related to the previous achievements. The linkage between subsequent parts of the academic backbone is measured through correlations. It however would be a simplistic approach towards the understanding of academic backbone model. This model is not only the assessment outcome at one stage predicts the assessment outcome the next level or thereafter, but it is the achievement of knowledge at one level which provides the basis of building new knowledge at later stages. These conjoined sets of knowledge including theoretical understanding and accumulation of practical skills form the medical capital for a successful medical practice.

The centrality of testing in educational curriculum is unequivocal. "What gets assessed is what is learned" is a common assertion, the meaning of which is often underestimated. It is not just what gets assessed, but how it is assessed that has implications for what is learned (Johnston and Costello, 2005) .and how it is learned. With growing understanding of intricate relationship of psychology of learning and teaching, educational measurement and psychometric analysis of tests, assessors and test developers are held accountable for using the test scores to make inferences. This intricate development has led to validation exercises as an essential process in test evaluation (Streiner & Norman, 2008). The power of validity is the most significant measure, while evaluating the worth of a given test (Mehrens, 1987). In order to interpret assessments meaningfully in medical education requires evidence of validity (Downing, 2003). The important aspects of test quality were highlighted by psychometric theorists, since the early 20th century, who also suggested means for validating tests. In addition, since the 1950s, formal guidelines are published for test developers and test users to clarify what validity is and how tests should be evaluated (Sireci & Parker, 2006).

Shulruf et al. (2012b) quoted Neils Bohr saying ''Prediction is very difficult, especially about the future.''(pg 631) forewarning the difficulty in prediction. Messick (1995) introduces validity as an evaluative judgment of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of interpretations and actions on the basis of test scores or other modes of assessment. He further explains that the validity is not a property of the test or assessment as such, but rather of the meaning of the test scores. Thus, it is the meaning or interpretation of the score and action taken thereafter needs to be valid (Cronbach and Meehl, 1955). Therefore, the importance of meaning and decision making based on the scores remains central in educational testing discourses.

Downing (2003) summarises validity as an approach which uses theory, logic and the scientific method to collect and assemble data to support or fail to support the proposed score interpretations. Hence, the validity of decisions depends on the evidence that the test is able to measure what it is supposed to measure. Two types of validity i.e. logical and empirical are mentioned in earlier writings related to validity. These were later recognised as content validity, predictive validity, concurrent validity and construct validity (Caffrey et al., 2008).

The empirical evidence regarding validity should come from different sources (Norcini, 1999). It is because strong evidence from one data source does not necessarily support the inference or action taken or undermine the need of other evidence. Different decisions are made on the basis of different data sources. Downing (2003), based on the type of validity required, proposed to collect data from the content of the test instrument, test response process, internal structure of test instrument, correlation of scores to other measures and the consequences of the test sores.

Predictive validity is the power of a given test to anticipate the future measure of performance of a person on construct(s) of interest. The predictive power is measured by the correlation between the performances measuring constructs. A weak correlation indicates the difference of constructs measured at two different occasions by two equivalent tests. Regarding medical college admission test, different performance measures such as medical licencing examination, clinical skills assessment, certifying examinations, professionalism evaluation and other competencies are used for correlation purposes.

The US Department of Labor, Employment Training and Administration has published guidelines, 1999 cited by Emery and Bell (2009) interpreting correlation coefficients in predictive validity studies. The guidelines suggest that the coefficient values > 0.35 are considered as very beneficial, between 0.21–0.35 as likely to be useful, between 0.11–0.20 as dependent on circumstances and those < 0.11 as unlikely to be useful.

In the literature various independent and dependent variables are used by researchers to measure predictive validity of tests. Independent variables including both academic and non-academic variables like: total or component scores achieved in entrance tests, prior scholastic achievements indicated by grade point average (GPA) in different subjects or overall, level of courses taken, quality of institutions attended before, type of personality possessed, sex, age, race and socio-economical background have been used in different studies. Various dependent variables used include performance in pre-clinical and clinical years at medical schools, licencing examination scores and performance during residency, delayed graduation, withdrawal or dismissal from academic programme were also studied.

Although the aims of educational assessment are to measure current achievement, predict future achievement and prescribe educational treatments (Caffrey et al., 2008), the MCAT was not instituted to predict future performance rather the capability to complete the medical programme (McGaghei, 2002). Most of the studies related to MCAT addressed its predictive power. Even though MCAT is widely used for medical schools, it has also shown equal validity results for other programmes like podiatry (Petek & Todd, 1991). Since its inception, MCAT has undergone several revisions. The predictive validity of last three versions of MCAT was studied at Jefferson Medical College.

While MCAT subtest scores were the independent predictor variables, the performance in medical school, attrition, scores on the medical licensing examinations, and ratings of clinical competence in the first year of residency were the dependent criterion variables. The results showed that there was no significant improvement in validity coefficients observed for performance in medical school or residency. Validity coefficients for all three versions of the MCAT in predicting USMLE Part I/Step 1 remained stable (in the mid-0.40s, p <.01). A systematic decline was observed in the validity coefficients of the MCAT versions in predicting USLME Part II/Step 2. They started at 0.47 for the pre-1978 version, decreased to between 0.42 and 0.40 for the 1978– 1991versions, and to 0.37 for the post-1991 version. Validity coefficients for the MCAT versions in predicting USLME Part III/Step 3 remained near 0.30. These were generally larger for women than men (Callahan et al., 2010a). The findings when old and new MCAT were compared for predictive validity were similar. Although increase in predictive validity was not obvious in the New MCAT versus the old, stability of scores might be better (Essex et al., 1980).

In a meta-analysis to determine the predictive validity of MCAT on performance in medical schools and licensing examination Donnon et al (2007) found that a predictive validity coefficient for the MCAT ranged from small to medium for both medical school performance and medical board licensing exam measures. A predictive validity coefficient for the MCAT in the preclinical years of r = 0.39 (95% confidence interval [CI], 0.21-0.54) and on the USMLE Step 1 of r = 0.60 (95% CI, 0.50-0.67). Regarding different subsets of MCAT, biological science was found to be the best predictor of medical school performance in the preclinical years (r = 0.32 95% CI, 0.21-0.42) and on the USMLE Step 1 (r = 0.48 95% CI, 0.41-0.54).

Besides different predictive power of different versions of MCAT, various subsets of MCAT have also been investigated. Of the various subsets of MCAT, the best predictor of preclinical and USMLE step I performance was biological sciences subset. Its respective correlations were (r = 0.32 95% CI, 0.21 – 0.42) and (r = 0.48 95%CI, 0.41 – 0.54). Chemistry subset scores predicted pre-clinical year GPA and NBME Part I scores, while science problem solving and reading predicted pharmacology and behavioural science scores (Brooks et al, 1981). Previously, for NBME part I performance, Essex et al (1980) reported science component as a better predictor in the old version of MCAT and Chemistry in the new version of MCAT.

The writing sample was included in MCAT based on assumption that it is a measure of written communication, and candidates with good written communication would also be good in oral communication required in future physician-patient interaction. Due to its importance, the writing sample of MCAT has been studied separately as well. In a model containing GPA and all other admission test scores, as predictors of licensing examination scores, the writing sample variable did not add to the ability to predict Step I or Step 2 scores. Writing Sample demonstrated low, but consistent, correlation with Steps 1 and 2 of the licensing examination, r = 0.11 and r = 0.12 respectively (Gilbert et al., 2002). This low correlation is in contrast with findings presented by Hojat et al (2000). Hojat and associates (2000) in another medical school found that the Writing Sample was predictive of Step 2 performance. This difference in findings warrants individual school based evaluation of Writing Samples of MCAT.

While most predictive validity studies focus on MCAT, some researchers studied other entrance test like UMAT in Australia. It was suggested that UMAT has limited predictive validity of academic performance. The UMAT was started by University of Newcastle and later developed by the Australian Council for Educational Research. The

UMAT has three sections with multiple choice format questions having one correct response. The section I is logical reasoning and problem solving consists of text or graphs where candidates are required to exercise reasoning and problem-solving skills. Section 2 is understanding people section which assesses candidates' abilities to understand and think about people in a specific scenario. Section 3 is a non-verbal reasoning section which consists of abstract items evaluating non- verbal reasoning abilities of candidates (Ferguson et al., 2002; The Australian Council for Educational Research, 2016). In a study at the School of Medicine, University of Queensland, it was found that mean overall UMAT score at entry was 60/100 and mean GPA during university study was 6.1 (range, 1–7), with a r = 0.15 (p=0.005). This relationship between UMAT score and mean GPA during university education existed only in the first year of university study. The correlation between university GPA and UMAT Section 1 score, r = 0.14 (p=0.01); the correlation between university GPA and UMAT Section 2, r = 0.06 (p=0.29); and the correlation between university GPA and UMAT Section 3, r = 0.09 (p= 0.11). UMAT overall score for men (60.2) and women (59.8), and GPA for men (6.1) and women (6.2) were similar. However, men performed better in Section 1 (mean score 61.6 v 61; p=0.05) and Section 3 (63.2 v 60.7; p<0.001), whereas women performed better in Section 2 (58.5 v 55.8; p=0.009). In multivariate analysis, the only significant correlation was between GPA and UMAT Section 1 score. This remained significant but weak and lasted for one year of university study (Wilkinson et al., 2011). Another study, at Queensland University, proposed to assess how well prior academic performance, admission tests, and interviews predict academic performance in a graduate medical school. It was concluded that the school's selection criteria only modestly predict academic performance. GPA is most strongly associated with performance, followed by interview score and GAMSAT score (Wilkinson et al., 2008).

McManus et al. (2003) and McManus et al. (2013) highlighted the academic significance of school achievements in predicting the performance during medical education at both undergraduate and post graduate level. McManus et al. (2003) reported that GCSE and A-Level examination grades are inflated, meaning these are left-skewed and kurtotic, and the outcome variables measured during the medical education are also not normally distributed. While analysing the academic performance of entrants at one medical college they reported that the correlation of GCSE and A-level with five years of medical education ranged from 0.128 – 0.249 with the p < 0.001 and 0.180 – 0.279 with p <0.001 respectively.

The correlation between first to fifth years of medical education was also > 0.5 with $p < 0.001$. The correlation between the written and practical components of five years was 0.636 with $p < 0.001$. These two components also have similar high correlation with GCSE at 0.12 and 0.13 with $p < 0.00$, and with A-level at 0.339 and 0.279 with $p < 0.001$ respectively. The correlations of grades in initial two years and clinical sciences grades of later three years suggest that GCSEs predict performance of clinical sciences better than basic medical sciences performance. The multiple regression analysis of clinical performance on mean GCSE points and points of best three A-levels gave β coefficients of 0.204 ($P<0.001$) and 0.119 ($P = 0.01$) respectively. Furthermore, the basic medical sciences performance was only predicted by three best A-levels ($\beta = 0.283$, $P<0.001$), and GCSEs were not significant ($\beta = 0.020$, $P = 0.668$). While reporting on gender effects on grades, they reported that males underperformed females in GCSE and in clinical year assessments. After comparing their study findings of one medical school with cohorts of students at other schools, they found similar patterns of correlations between school attainments and grades in medical schools. They concluded that the later academic performance in medicine does not only correlate with the performance during medical school but also to the performance during secondary school as well.

In the literature, the issue of predictive validity of MCAT influenced by coaching and undergraduate institutions from which students are coming are also debated. It is disputed that commercial coaching improves students' performance in MCAT. Some studies demonstrate the link between the two and others do not. In an analysis by Jones and Vanyur (1986), the assumption that commercial coaching courses inflate the MCAT score and mask future performance of student was not maintained. While commercial coaching does not play any inflating role, the institutions students come from does make striking differences (Zeleznik et al, 1987). This observation raises a concern about the phenomenon in which same predictor variable across different institutions behave differently. The possible explanation could be difference in institutional educational system including curriculum content and method of teaching and assessment which is in line with MCAT.

Besides coaching and institutional effects on predictive validity measures of MCAT, effects of race/ethnicity were also examined. In a study by Koenig et al. (1998) on two large samples of students who entered medical schools and took USMLE Step I, major questions regarding differential validity of MCAT for individuals grouped based on race/ethnicity and sex were investigated. It was observed that on average there was no evidence of difference between sexes in prediction errors and while the performance of ethnic minority were over-predicted especially for Asians and Hispanics, that of Caucasians tended to be under-predicted. The comparison of predicted performance and actual performance yield the information regarding prediction error. The difference between predicted and actual performance shows a test bias. When the actual performance is better than the predicted performance it is referred as "under prediction" and the opposite is referred as "over prediction".

Female students performed better than male students during their undergraduate medical education assessment in First and Second Examinations for medical degrees. The female students scored statistically significantly higher than those obtained by male students (t-statistics=4.009 and 6.416, respectively, $p<0.001$ for both examinations), and sex and school level achievements in language are statistically strong predictors of performance in medical schools (Hewage et al., 2011).

The bias of selecting a small number of female students after having aptitude test for medical studies was pointed out by Mitterauer et al. (2008). In the study conducted at Medical University of Vienna, they found that on average, the success rate of female students was 28.0%, as compared to that of male students was 39.4% (Odds Ratio for females OR=1.67, 95%CI 1.44–1.97, P< 0.001).

While measuring the predictive power of pre university achievements, of the students selected in medical school on the basis of different admission criteria, for the performance in medical school (Schripsema et al., 2014) shared interesting research findings from one medical school. They reported the mean age of the students admitted during the same time was 18.6. They reported that the students admitted based on different admission processes showed statistically significant differences in the study performance during medical education. The students admitted on the basis of pre-university GPA performed best on all outcome measures as compared to students admitted based on lottery. They found similarity between their study and few others done before. The mean written test scores differed between groups ($F_{3,1025} = 63.20$; $p < 0.001$). Bonferroni post hoc multiple-comparison tests showed that the top pre-university GPA group had a higher mean test score than all other groups (mean difference [MD]: 1.0–1.3, standard error [SE]: 0.10; $p < 0.001$). The group that was accepted in the multifaceted selection process achieved higher scores than the lottery- admitted group that had not participated in this process (MD: 0.30, SE: 0.08; $p < 0.01$).

In a longitudinal study investigating the association between UMAT, socio-economic characteristics and undergraduate performance of students in a dental surgery programme; Rich et al. (2012) found that preadmission academic attainment and UMAT failed to predict the performance of the students. However, the class place in 2nd year strongly predicted the performance in the final year. This prediction is line with the understanding that the early performance in the dental course is a better predictor of later performance than the preadmission attainments. They also found the positive effect of ethnicity and residential status of students on their performance. They also reported the better academic performance of females more than males.

The admission in the medical schools of Iran is solely based on the performance of candidates on Konkoor examination conducted nationwide. Kokoor examination is conducted for the last 50 years. It is a comprehensive examination which includes the topics taught in high schools. It is conducted once a year and has multiple-choice assessment format with one correct answer. Farrokhi-Khajeh-Pasha et al. (2012) investigated the predictive validity of the Konkoor examination grades alone and in combination with high school GPA (hsGPA). They measured these dependent variables against comprehensive basic sciences examination scores (CBSE), comprehensive pre-internship examination (CPIE) scores and medical school GPA (msGPA) as outcome variables. They reported that among variables, the Konkoor total had the strongest association with CBSE score ($r = 0.473$), followed by msGPA ($r = 0.339$) and the CPIE ($r = 0.326$). While adding hsGPAs to the Konkoor total score almost doubled the power to predict msGPAs ($R^2 = 0.225$), it did not have a substantial effect on CBSE or CPIE prediction. The Konkoor examination performance individually or in combination with hsGPA, is a poor predictor of the future academic performance of students. In addition the predictive validity of Konkoor scores declines over the academic years of medical school.

While determining the predictive validity of prior attainment, UMAT and oral assessment in bachelor of health programme, Gardner and Roberts-Thomson (2012) found that prior academic achievement is a strong predictor of performance of students during the programme, and suggested to raise its cut-off while reducing the emphasis on UMAT will increase the pool of applicants for the programme.

In many countries including UK, Australia and Pakistan there are public and private school types offering education till year-XII. Also different types of assessments are used for selection in medical schools in different countries. While questioning the role of the UKCAT in improving the selection process of medical students, Wright and Bradley (2010) reported that previous school types did not significantly predict the performance in interview or UKCAT. However, personal statement scores were significantly related to the type of schooling. The students from private schools performed better than students from state maintained schools. Furthermore, during the medical education, type of school attended and personal statements were not a significant predictor of performance in knowledge assessments. The UKCAT scores did predict the performance in knowledge examination for most assessments in initial two years of curriculum. However, the admission data did not explain much about the assessment in clinical years.

In a cross sectional study analysing the effects of pre-admission eligibility and selection criteria on the performance during medical education, Gupta et al. (2013) observed that previous academic performance is a useful indicator of future in-course performance. However, the lower cut-off values could be problematic in predicting the performance of some students. They found the entrance test as a poor predictor of future performance. Hence, they suggested reforming the selection process in medical school to admit students who perform better in medical course. Bhatti and Anwar (2012) reported that in the admission based on merit criteria, SSC and HSSC are of great importance in predicting future performance. The SSC and HSSC exams and entrance test scores has a correlation of 0.439 with $p < 0.00$. The SSC and HSSC scores correlate with first year and second year percentage r= 0.452 and r=0.372 respectively having $p < 0.001$. While entry test negatively correlates with the percentage of first year and second year undergraduate medical education r= -0.537 and -0.469 respectively with a $p < 0.001$. They have under emphasised the role of entrance test in admission as it does not predict future performance. It's not the effective tool to be used as entry criteria or as a standard method. They also reported that more female students are successful in getting admission in medical schools and students who showed poor performance in SSC and HSSC examinations and entrance test show similar poor performance in first year only. In contrast with Bhatti and Anwar (2012), Khan et al. (2014) suggested that due to poor predictive validity of HSSC and SSC for the performance during initial years in medical schools, their weightage in admission should be reduced.

Furthermore, the entrance and aptitude tests have high predictive validity. Khan et al. (2013) studied the predictive validity of HSSC examination and MCAT marks for achievement in initial years of medical education. They reported that the difference in the performance of male and female students in HSSC and entrance test is not statistically significant. While at the end of first year of undergraduate medical education, females (M = 718.16) performed statistically significantly higher than males (M = 704), with $p < 0.001$. In 2008 and 2009, females occupied 68.9% and 67.08% of the total available medical college seats. The better performance of female students is attributed to the protective and supportive environment provided to females in a predominantly Muslim society. This could help them to focus their energies towards educational activities hence their resultant higher grades.

Hamdy et al. (2010 a) and Hamdy et al. (2010 b) gave an overview of the practices and challenges of undergraduate medical education in the Gulf Cooperation Council (GCC) countries (Saudi Arabia, Bahrain, Qatar, United Arab Emirates, Oman, and Kuwait). They briefly described the student selection process in a separate section of the report for each of the member countries. In Saudi Arabia candidates for the admission in medical programmes, are required to sit for a College Aptitude Test (CAT). In the United Arab Emirates admission is based on the academic performance in high school and English language proficiency tests. In Sultanate of Oman admission to the medical school also depends on academic performance on the high school examination and proficiency in the English language. In the Arabian Gulf University at Bahrain the selection criteria include academic performance in high school, admission examination and an interview. In Kuwait University, initially students were admitted directly from high school and were selected by their results (GPA) from secondary school. In 1997, it was decided that the applicants to the School of Medicine, Dentistry and Pharmacy should be admitted to a 'common first year' following which they will be distributed to the three health sciences colleges according to their GPA and their preference. The Weill Cornell Medical College at Doha Qatar requires applicants to demonstrate an outstanding academic merit upon graduation from secondary school with satisfactory performance in standardized tests (the SAT Reasoning Test or ACT with Writing and SAT subject tests in mathematics and two relevant sciences) and proficiency in English language for admission. A personal statement on their interest and suitability for the career in medicine is also required.

In medical schools the challenge, of choosing the appropriate selection tools based on their predictive power of future performance, remains complex and does not have not easy solution. While comparing three selection tools; admission GPA, UMAT and structured interview for the future performance of students in a medical school, Shulruf et al. (2012a) found the admission GPA, a prior academic achievement measure, as a powerful predictor of achievement in initial years 2 and 3 of medical curriculum with regression coefficient value for (B) of 1.31 and 0.9 respectively, both with a significance level of $p < 0.001$. They concluded that the prior academic achievement is the best measure of later achievement in the medical school assessments. In the same study they did not find any significant role of gender on the outcomes measured and the correlation between different tools was low (-0.313 – 0.384) although statistically significant at $p < 0.05$.

Are the performance measured criteria and preadmission predictor variables studied perfect, or is there a need to explore additional variables? Although MCAT and undergraduate GPA are good predictors for future performance, they are not perfect. Koenig et al (1998) suggested that variables like conscientiousness, enthusiasm, communication skills, study habits and other similar characteristics be examined as predictive variables. Also success in the medical profession should not only be measured by high grades in medical school and USMLE but other important qualities such as professional integrity, interpersonal skills, ability to be caring and compassionate, commitment towards lifelong learning and obligation to serve in areas which are poorly served, should also be considered as performance measures.

Assessment of personality traits is gaining its significance in the selection processes of medical schools (Dowell et al., 2011; Haidinger et al., 2006; Liao et al., 2014). In recent years the research showing a relationship between personality and performance provided varying evidences to include or not to include personality assessment in the medical school selection processes. It however is not an easy process to assess the personality of applicants accurately, as students are likely to mask their real personality trait while completing self-report tests of personality used for selection (Griffin & Wilson, 2012).

This chapter demonstrated the significance of selection process in addressing the issue of poor health care delivery. A possible solution of the issue is the selection of appropriate health care professionals. There are different assessment tools used to evaluate the candidates, among them medical college admission test is one. In Pakistan the use of entrance test for admission in to medical college is a relatively recent phenomenon. There is a knowledge gap regarding the educational value of this test. Unlike many other admission tests used in different parts of the world, the entrance test used in medical schools Pakistan, specifically in public medical schools, is not examined comprehensively. It is not known whether the test is adding any valuable information or not.

CHAPTER THREE

RESEARCH QUESTION AND METHODOLOGY

This chapter starts with the research question derived from the context of the study and literature. Following the research question is the methodology section which presents research site, participants, study design and data and statistical techniques used to analyse the data. This chapter also presents some initial results in order to justify the use of different statistical tests.

RESEARCH QUESTION

As the compulsory use of entrance tests is a relatively new phenomenon in Pakistan and these are high-stake examinations, it is imperative to evaluate the logical, psychometric and empirical evidence to justify their prominent role in decision making during selection processes in medical schools. The entrance tests are theorized as an important screening process for selection of appropriate candidates. The predictive power of any process should show logical, psychometric and empirical consistency. The logical fitness of process needs to be verified empirically by measuring its predictive power (van de Vliert, 1981). The measure of predictive power of any entrance test has been considered as the most important empirical evidence to justify the significance of the test in decision making. After the Flexner report emphasising the improvement of medical education by making different recommendations including enhancing standard of entrance in medical schools, MCAT was instituted in 1928. Among various admission tests used by different medical colleges of different countries, MCAT is widely researched in order to study and justify the use of test and decisions made on the basis of performance in the test. The research on MCAT forms the literature source of many similar studies including this. To the best of my knowledge, from Pakistan there is no robust published study focusing on the educational and moral value of current entrance tests conducted in public medical schools. Studies by Bhatti and Anwar (2012), Khan et al. (2013) , Khan et al. (2014) and Mufti et al. (2014) are limited in their scope and statistical strength. The main research question raised in this study regarding the education value is: to what extent the entrance test and other component parts considered for admission in medical university or school predict the future cognitive performance of candidates.

METHODOLOGY

Study Site:

This study was conducted at two public medical universities of Pakistan. The criteria of selection of study site were (i) public medical college(s) and or University(ies) using university entrance test as one of the requirements of admission process, (ii) have at least one batch of students graduated who took the entrance test, (iii) have assessment records of registered students, and (iv) have at least one hundred students admitted each year. Three universities were contacted to seek permission for sharing the data. Letters detailing the research aim were sent to different universities. Out of contacted universities, four showed willingness to share the data. The Research proposal was shared with them in various face to face meetings. Three universities agreed to participate initially but later one university decided to withdraw from the study. The remaining two universities fulfilled the selection criteria and were selected for the study. Each study site was located in different parts of the country. The study proposal and significance was shared with the vice chancellors and their designated officials as part of seeking permission to conduct the study.

Study design and data:

The proposed study is retrospective, quantitative and longitudinal in its design. The data of students admitted in years 2004, 2005, 2006 and 2007 were collected. The data sources were the official records showing students' preadmission information and assessment scores achieved during undergraduate medical education. Data of various predictor or independent variables and outcome measures or dependent variables were collected. The identity of each student was removed and replaced with a code i.e. the data were collected in re-identifiable form. The relevant officials were requested to code the data before sharing.

The preadmission information including candidates' demographics i.e. age, gender and residential address at the time of admission, parental information, financial support, school system attended (a proxy of socio-economic status of student), cumulative and subject (English, Sindhi and Urdu language, Biology, Physics and Chemistry) scores achieved in SSC examination (equal to grade-X), HSSC examination (equal to grade XI and XII), university entrance test scores and cumulative admission scores (combined SSC, HSSC and NTS scores) achieved by candidates were requested. However, the information regarding all the independent variables of interest was not available for all the candidates.

The scores achieved by students in scheduled assessments during undergraduate medical education were available. The scheduled assessments included end-of-the-semester assessments and annual examinations. The scores achieved by students in different semesters and years, in different subjects and the total scores achieved in basic sciences, clinical sciences and MBBS were collected. The basic sciences include disciplines of anatomy, physiology, biochemistry, pathology, pharmacology and forensic medicine. The clinical sciences include medicine (including psychiatry), surgery, obstetrics and gynecology, pediatrics, otolaryngology and ophthalmology. The score of each of the basic science disciplines is composed of a written theory part and practical skills component. The score of each of the clinical science disciplines is composed of written theory and clinical skills components. The written component of examination is assumed to assess the theoretical knowledge while the practical and clinical examinations assess laboratory and clinical skills of students.

The scores of SSC and HSSC were provided in the form of raw scores and in the percentage scores required to calculate the final cumulative score for admission. The university entrance test scores were provided in percentage format mostly. All the assessment scores achieved by the students during undergraduate medical education were provided as in the percentage format.

Participants:

Admission and assessment records of total seven batches of graduates were collected. The data of a total 2258 graduates were collected from two different universities.

Medical University A - NMC:

In April 1974 this premier public medical college for girls was inaugurated at Nawabshah; a non- metropolitan city of Pakistan. So far about 6000 female doctors have completed their undergraduate medical studies from this college. This medical college was upgraded to university in 2010. This medical university takes approximately 200 students each year in the MBBS programme offered. The admission processes and curriculum in this medical university is similar to other public medical universities, schools or colleges in Pakistan. The process of admission is same in other public medical universities and colleges.

Medical University B - LMC

This medical university is one of the oldest medical institutes of current Pakistan. It was established in 1881 in undivided India-Pakistan. Later in 1951this College was re-established in city of Hyderabad, and in 1963 it was relocated to its current location in Jamshoro located in the outskirts of Hyderabad a metropolitan city. It offered only MBBS course initially, later in 1963 it started Bachelor of Dental Surgery (BDS) course as well. In 1989, this medical college acquired the status of postgraduate medical institute. And in 2001 this institute was up-graded to the level of university of medical and health sciences. This medical university admits approximately 350 students each year.

The courses, curricula and assessment processes at both medical universities are governed by the rules and regulation of Pakistan Medical and Dental Council (PMDC). The admission processes at both the sites are also similar and governed by PMDC guidelines.

Data analysis:

The data was analysed using Statistical Package for Social Sciences (SPSS) software version 21for windows by IBM SPSS. Initially a detailed descriptive analysis was carried out at the initial stage of analysis for all variables to explore and understand the characteristics of population under study and data. The T statistics and an analysis of variance (ANOVA) were conducted to analyse the dis/similarities between different batches of graduates, universities and students groups. The academic achievement in SSC grade X, HSSC grade XII, NTS entrance test, cumulative admission scores, basic sciences, clinical sciences and overall MBBS scores were compared across different groups of students based on sex, residential address, university attended and admission criteria. Later correlational and regression analyses were conducted to analyse the associations between different predictor and outcome variables. Also, regression analyses were performed to identify and measure the predictive power of various models of preadmission variables for the university entrance test achievement, basic science achievement, clinical science achievement and MBBS achievement as an undergraduate medical education performance outcome.

Statistical Techniques

Selection of appropriate statistical technique to analyse the relationship between different dependable and independent variable is important in order to make justifiable nferences. There are parametric and non-parametric statistical techniques. These both techniques are used based on the characteristics of the data. Parametric statistical techniques require quantitative dependent variables and are usually applied when these variables are measured on a scale which approximates interval characteristic and distribution of scores within the population of interest is normal. Parametric statistical techniques are used to analyse means, variance and sum of squares. As opposed to parametric statistical techniques, non-parametric statistical techniques are used for analysing quantitative variables that are measured on ordinal scale and the assumption of normality of distribution is not required.

Jammes and Michael (2002) pointed out the argument between the use of parametric and non-parametric techniques among researchers. In social science research the ideal normality of distribution is rarely observed. They argued that the parametric techniques are considered robust in producing results even if there are violations of the distributional assumptions. Hence, the frequency of different errors and accuracy of conclusions made are relatively unaffected compared with conditions when assumptions are met. The current data set fulfill the assumptions of parametric statistics. The normality of data distribution is shown in Fig 3.1 and Table 3.1 outlining the number of cases and other descriptive parameters, of some important variables, that are argued to be appropriate for employing parametric statistical techniques. In this study various parametric statistical tests, analysing the relationship between different variables, including *t* test, analysis of variance, regression analysis and Pearson correlation will be employed.

Student t test

In this study we employed independent group *t* test to analyse the differences between two dichotomous groups. The assumptions for using this statistical *t* test include, having two simple random samples from two distinct populations, samples are independent, independent variables have two and only two levels and is between-subjects, dependent variable is quantitative in nature and is measured on a level that is at least approximates interval characteristic, and populations are normally distributed (Jammes & Michael, 2002; Moore, 2000). Table 3.2 show descriptive and Fig 3.2 shows the distribution with normality curve of some variables used for analysis in this study.

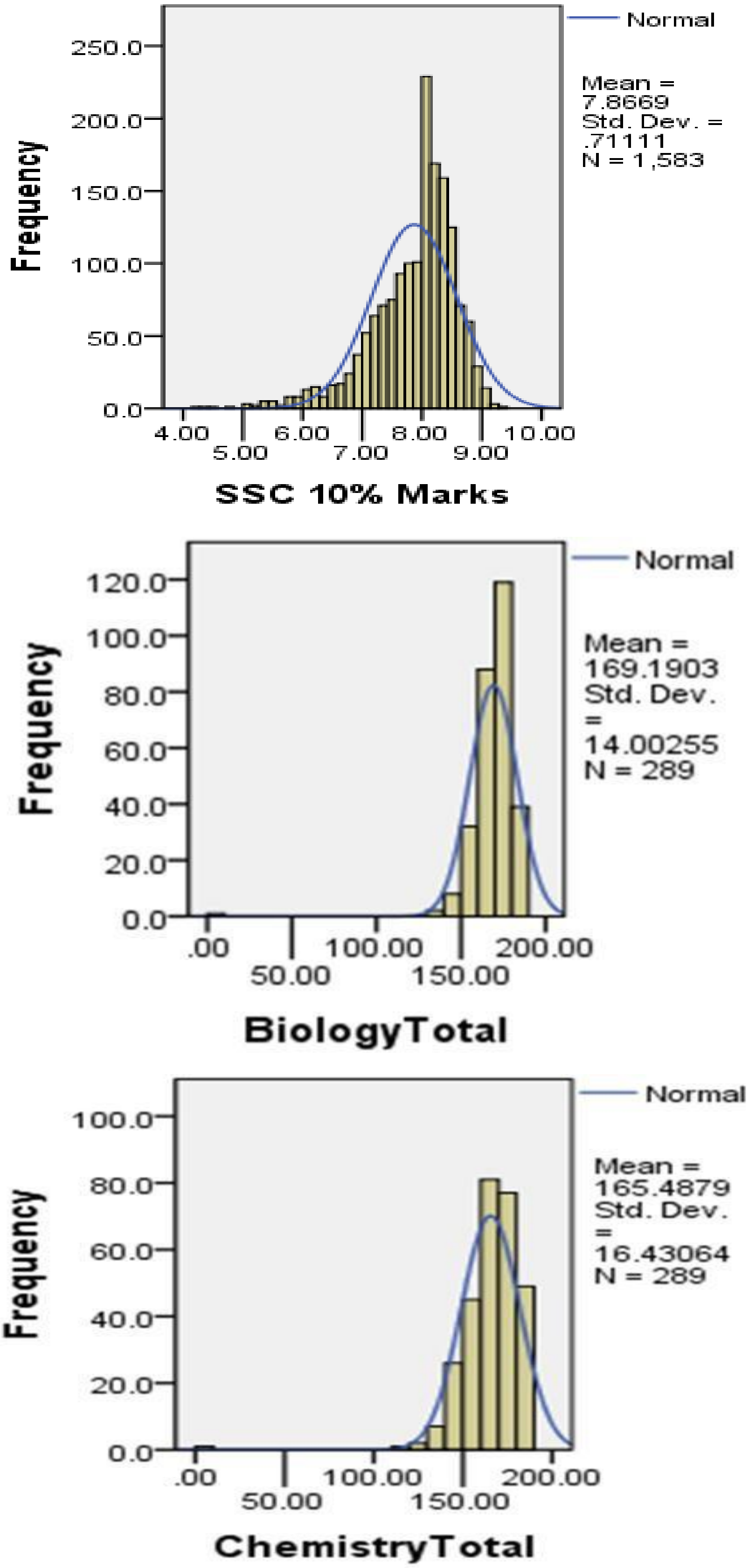
Analysis of Variance (ANOVA)

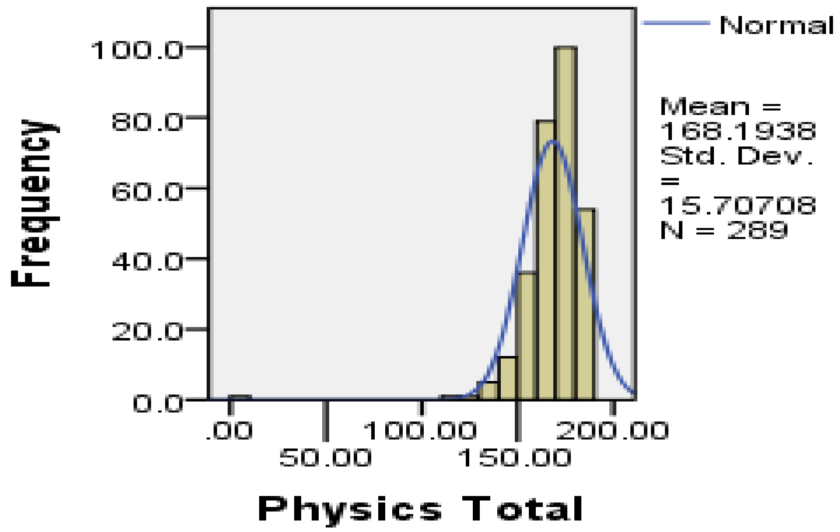
This is the statistical technique used to compare several means of more than two populations. As opposed to two-sample *t* statistics and its *p*-value to analyse the significance of difference in means, ANOVA uses F statistics and its *p*-value to test the null hypothesis of the similarity of means of several populations. In this study ANOVA is used to compare the means of different groups of students admitted in the medical universities during different calendar years. In order to examine the significance of means difference between two populations within several populations, methods like Tukey's HSD and Least significant Difference (LSD) were used.

Table3.1 Distribution of various variables.

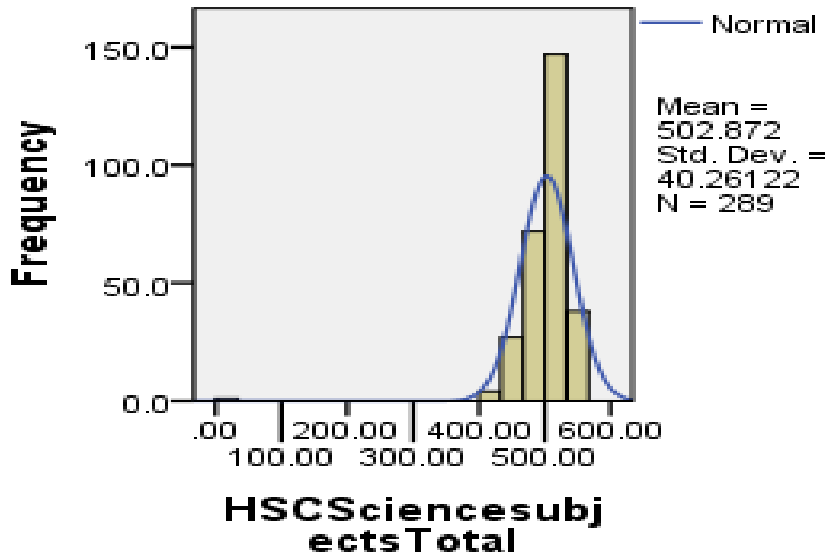
	N	Mean	Std. Deviation
SSC 10% Marks	1583	7.87	0.71
Biology Total	289	169.19	14.00
Chemistry Total	289	165.49	16.43
Physics Total	289	168.19	15.71
HSSC Science subjects Total	289	502.87	40.26
HSSC Language	777	358.76	30.50
HSC Three sub 40 %	780	32.59	2.28
HSC 40% of ALL subjects	1577	30.39	1.81
NTS50Percent	1583	28.57	8.94
Merit scores when 3 subjects are considered	942	64.19	7.61
Merit Scores when all HSC subjects are considered	1612	66.56	10.11
Basic Sciences Theory	1969	63.23	10.13
Basic Sciences Practical	1969	60.45	10.40
Basic Sciences Total	1969	61.97	10.03
Clinical Sciences Theory	1960	67.76	5.72
Clinical Sciences Practical	1960	67.87	8.12
Clinical Sciences Total	1960	67.81	6.09
MBBS Theory Total	697	68.10	5.50
MBBS Practical Skills Total	697	68.85	5.73
MBBS	1914	65.24	6.55

Figure 3.1 Graphs showing distribution of various variables.





Normal
Mean = 168.1938
Std. Dev. = 15.70708
N = 289
Frequency
100.0
80.0
60.0
40.0
20.0
0.0
.00
50.00
100.00
150.00
200.00
Physics Total



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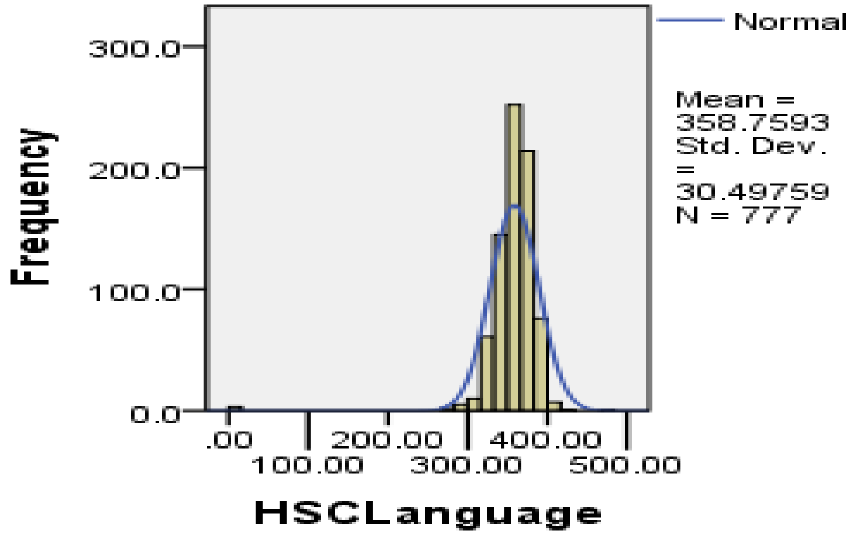
0.0
.00
100.00
200.00
300.00
400.00
500.00
600.00
HSCSciencesubjectsTotal



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.00
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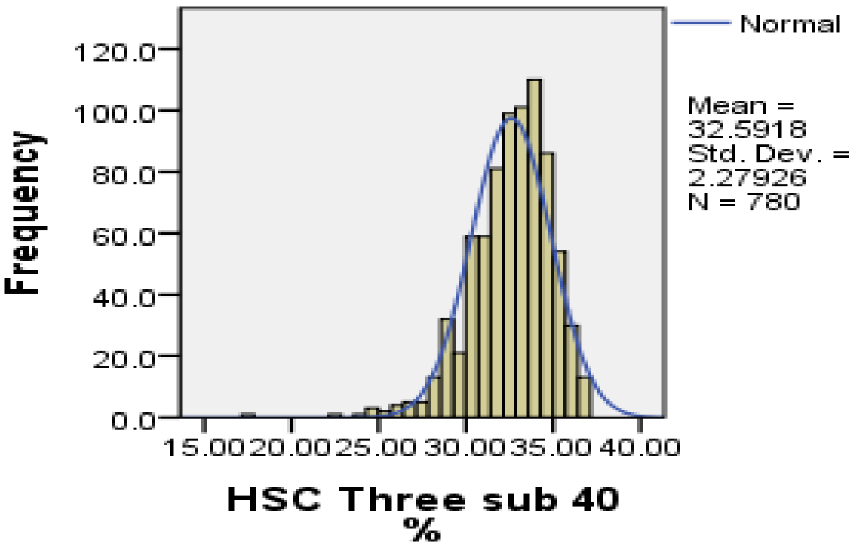
300.00
400.00
500.00
HSCLanguage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Frequency
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60.0
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20.0
0.0
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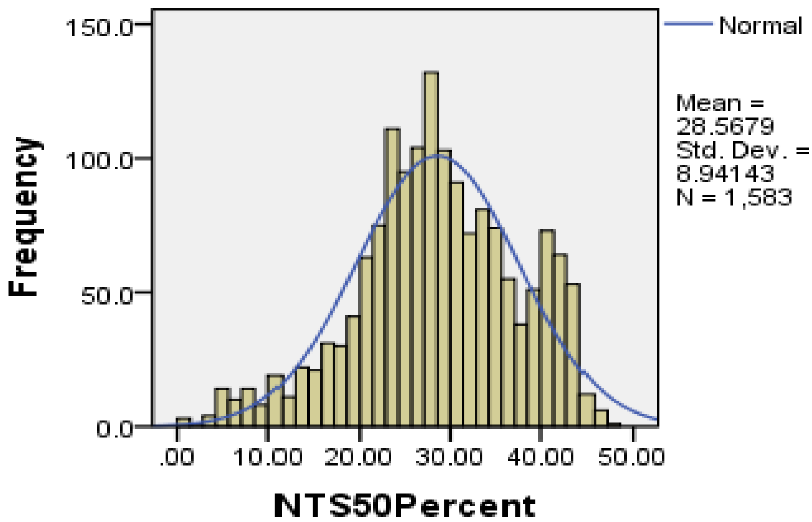
HSC Three sub 40 %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Std. Dev. = 8.94143
N = 1,583
Frequency
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50.0
0.0
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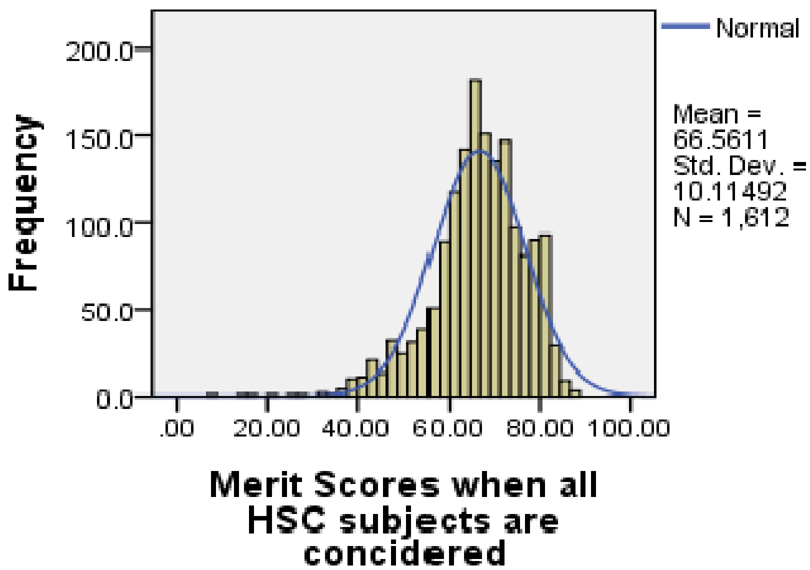
NTS50Percent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Std. Dev. = 10.11492
N = 1,612
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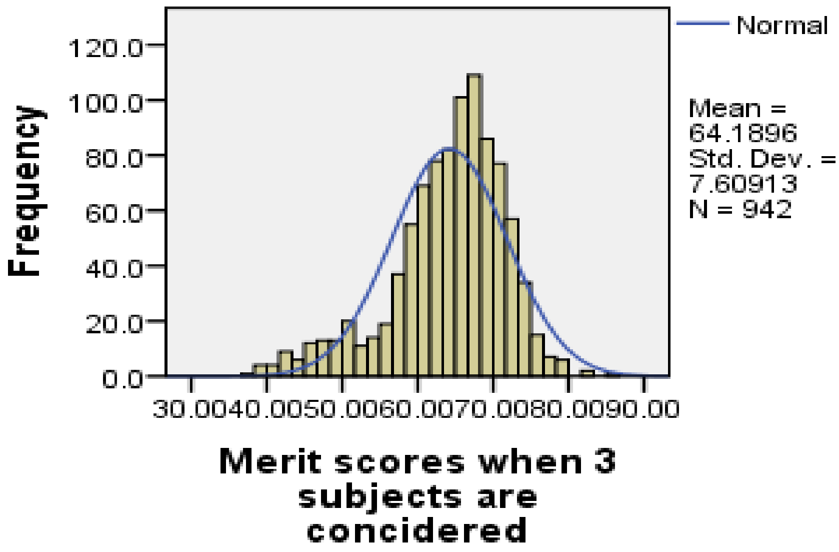
100.0
50.0
0.0
.00 20.00 40.00 60.00 80.00 100.00
Merit Scores when all HSC subjects are concidered


Frequency
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100.0
80.0
60.0
40.0
20.0
0.0
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Normal
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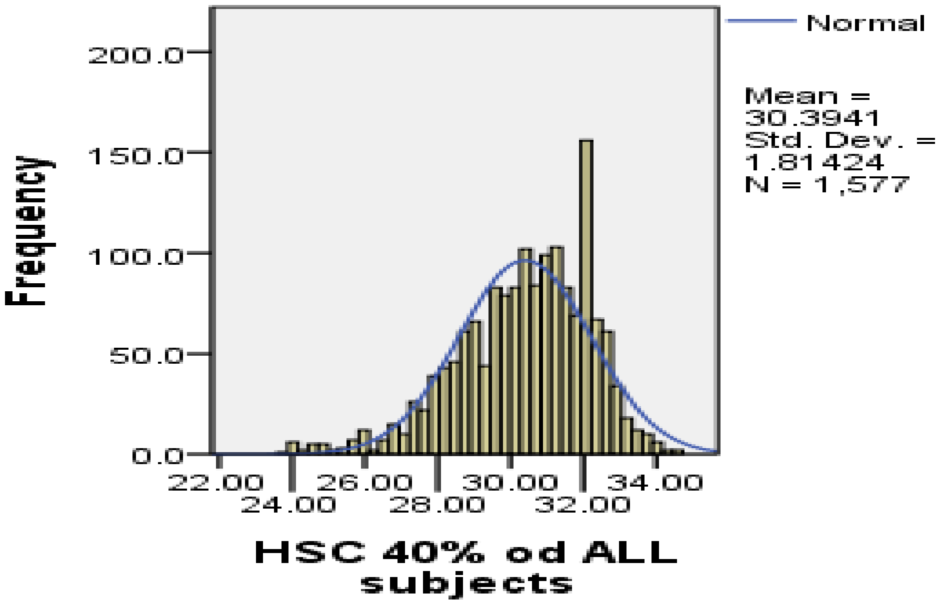
Std. Dev. = 7.60913
N = 942
Merit scores when 3 subjects are concidered


Frequency
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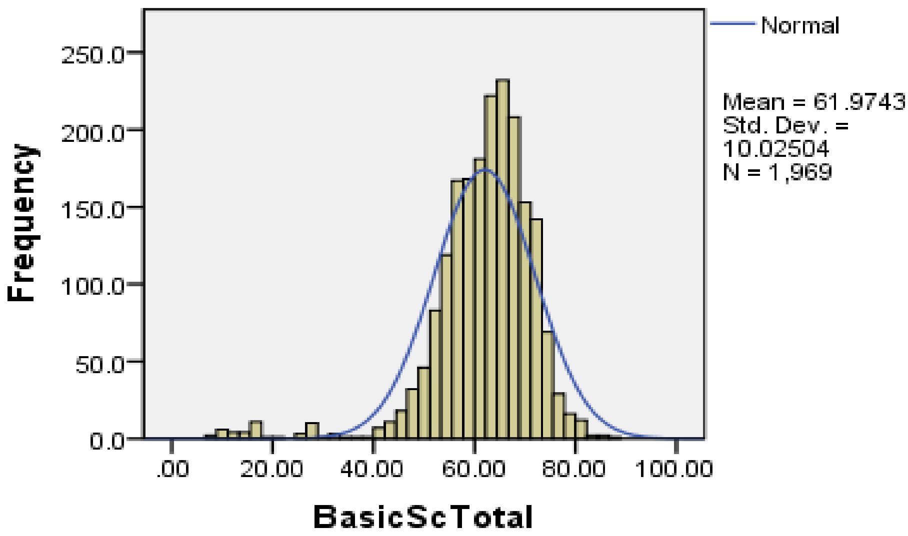
150.0
100.0
50.0
0.0
22.00
24.00
26.00
28.00
30.00
32.00
34.00
Normal
Mean = 30.3941
Std. Dev. = 1.81424
N = 1,577
HSC 40% od ALL subjects


Frequency
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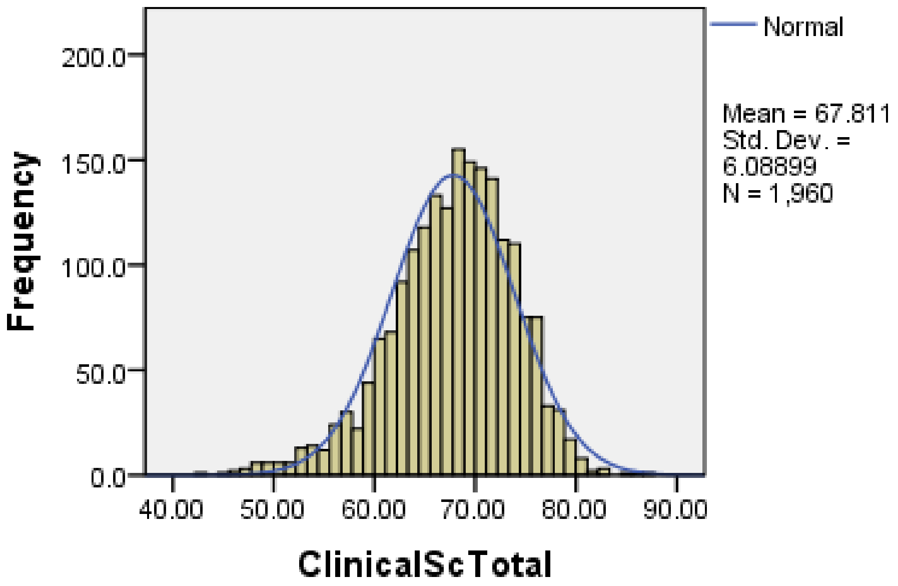
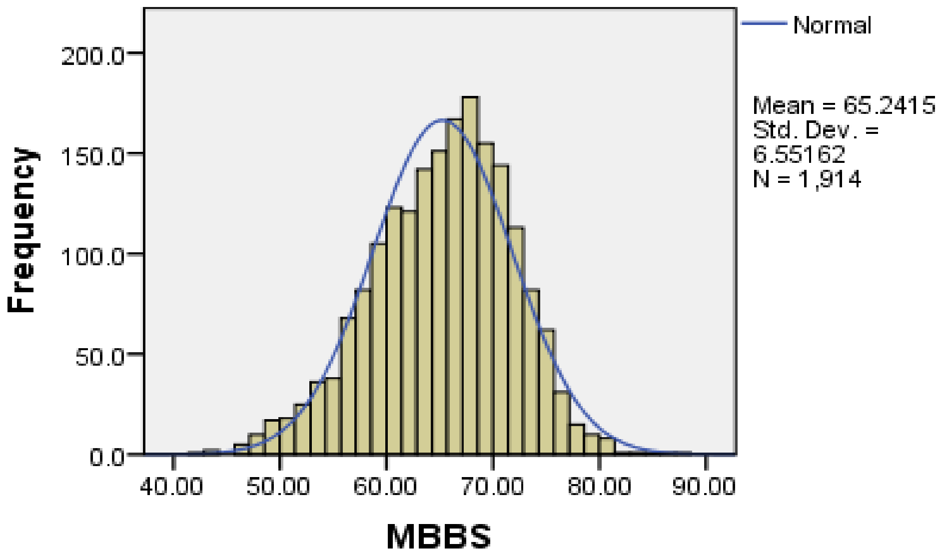
150.0
100.0
50.0
0.0
.00
20.00
40.00
60.00
80.00
100.00
Normal
Mean = 61.9743
Std. Dev. = 10.02504
N = 1,969
BasicScTotal





In social sciences research, including educational measurement research, measurement of two different variables for similar subjects is widely observed. How two different variables are associated to each other is a commonly probed research question. When variables under study are both quantitative, have many values and have at least interval characteristic scale of measurement, the statistical technique of *Pearson product-moment correlation* commonly called as Pearson correlation, can be used to determine the relationship between two variables. There are different ways in which two variables could be related to each other. However, social science research is mostly concerned with linear relationship. This linear relationship is far more uncommon in social sciences. It only approximates a linear relationship. The Pearson correlation coefficient is an index, represented by the letter r, which measures the linear approximation of two variables. The value of r can range from -1 through 0 to +1. The absolute value of r indicates the degree to which a linear relationship is approximated i.e. the magnitude. The further the value of r is from 0, the better is the relationship. The + ve & – ve signs of r indicate the direction of linear approximation. The + ve sign indicates a linear relationship that is direct in nature, while the –ve sign indicates an inverse linear relationship (Jammes & Michael, 2002).

Among various studies, in the field of medical education investigating the predictive relationship of various pre-school variables and performance of students during and after medical education (Brooks et al., 1981; Callahan et al., 2010b; Donnon et al., 2007; Gilbert et al., 2002; Stefanu & Farmer, 1971), correlation coefficient r is commonly employed technique of data analysis.

The data collected for this study satisfy the statistical characteristics required for employing the Pearson coefficient correlation technique, i.e. it is quantitative, has many values and has interval characteristic scale of measurement. The use of this statistical technique by other researchers investigating similar questions justifies its use in this study.

Multiple regressions

In addition to correlation, multiple regression analysis is a type of complex associational statistical method. It is based on correlational matrix of all variables to be considered in a problem. The general purpose of multiple regression is the prediction of a dependent, outcome or criterion variable from many independent or predictive variables. There are several methods of computing the multiple regression. In this study the stepwise regression method is used. As in this study there are relatively large set of variables which are thought to be good predictors of the outcome variables. Due to collinearity issue the predicting variables cannot be entered simultaneously without the loss of power to find the significance of predicting models. In stepwise method the correlation between all the predictor variables and outcome variable is computed. Then the variable which has the largest correlation is entered as first predictor variable. Next, the variable which changes the $R^2_{adjusted}$ value the most is entered. This process continues till all the predictor variables are considered and highest value of the $R^2_{adjusted}$ is achieved. During the process of computation, the removal of predictor variables is also considered to see if any improvement occurs in the value of $R^2_{adjusted}$. The value of $R^2_{adjusted}$ explains the % change in the outcome variable due to the proposed model of predictors.

Correlation and regression are powerful statistical techniques used to measure the associations between variables which express the dependency of one variable over the other. These techniques however do not imply causation. Also correlation and regression could be misleading due to lurking variables which are neither observed nor measured, and range restriction (Moore & McCabe, 1998).

CHAPTER FOUR

RESULTS

The results chapter is organised in two sections. The first section will provide the descriptive statistics of various variables to describe the sample and the second section will provide the statistical analysis. The first section will include the descriptive analysis of various observed variables used in the study which include frequency distribution, means and standard deviations. The second section will include the inferential statistical tests comparing the mean scores of different groups of cases by using student *t* test, ANOVA, Pearson product-moment correlations and regression analysis to measure the predictive power of different predictive variables.

SECTION-I

The descriptive statistics of registered students at two research sites admitted in the years 2004, 2005, 2006 and 2007 are presented here. Data from the admission and assessment records of 2258 students were collected. The data of various independent and dependent variables were entered in IBM Statistical Programme for Social Sciences (SPSS) version 21 SPSS for statistical analysis. Various variables have random missing data. As the number of cases and variables studied were sufficient, the cases with missing data for different variables were omitted list wise from further statistical analysis. The LMC has a greater student intake than the NMC. The medical LMC has 1822 students while NMC has 436 students.

The number of students in each year studied was different. This difference is because of different number of student intake and addition of failing students to subsequent classes. Figure 4.1 and 4.2 show the number of students at two medical universities admitted in different years.

The age variable was not available in the admission records. However, the age of students could be approximately calculated from the year of passing SSC or HSSC examinations and year of enrolment in the medical university. In Pakistan, children start grade-I at the age of five year. If a student completes the SSC grade X studies continuously without any break, failing or repeating a year, he or she would be 15 years old by the time of completion. And similarly he or she would be 18 years of age at the time of completion of

HSSC grade XII studies. Hence, if a student who completed HSSC in year 2004 and was enrolled in medical university in the same year, he or she would be 18 years of age. If he or she completed HSSC before, then the age would be one more year than expected. Table 4.1 shows the number of students who completed HSSC between year 2003 and 2007, and were enrolled in class of 2004, 2005, 2006 and 2007. The approximate age of students is given in the parenthesis. Based on year of completion of HSSC and enrolment in medical university, the average age of students at the time of enrolment is 18.17 years.

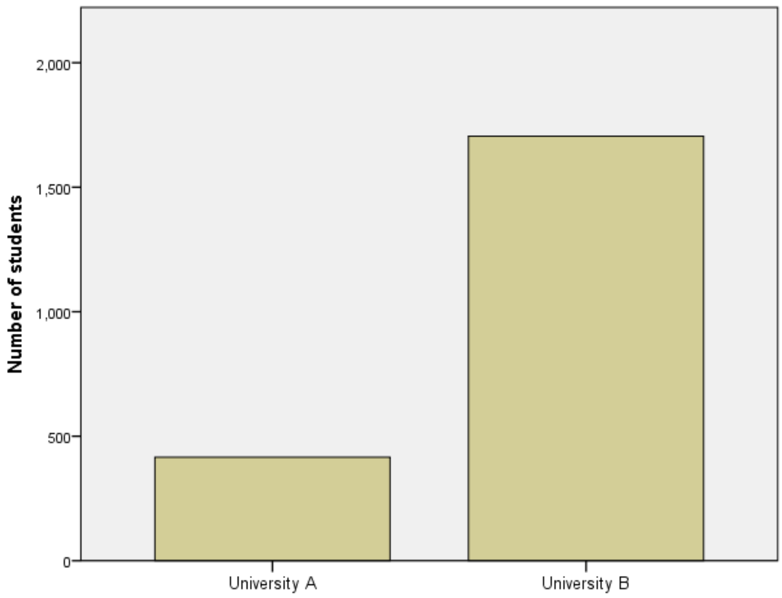
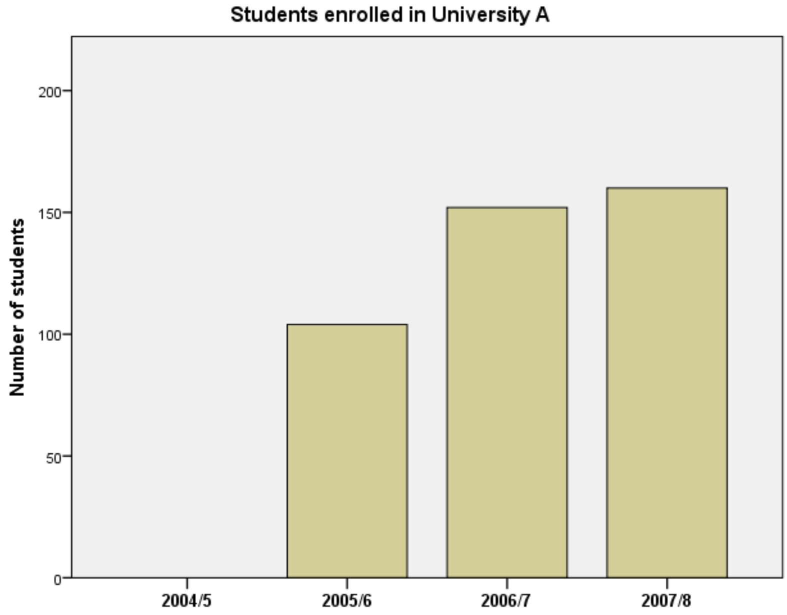


Figure 4.1 Number of registered students in two universities.



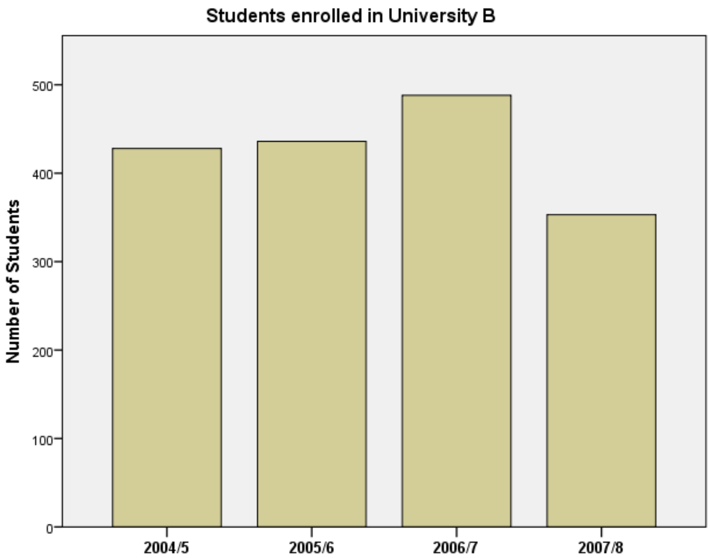


Figure 4.2 Number of registered students in two universities during different years.

Table 4.1: Number of Students admitted during different academic years (expected age)

	Enrolment Year			
HSC Completion Year	Class 2004 Number of Students (expected age)	Class 2005 Number of Students (expected age)	Class 2006 Number of Students (expected age)	Class 2007 Number of Students (expected age)
2003	72 (19)			
2004	308 (18)	85 (19)		
2005		366 (18)	68 (19)	
2006			358 (18)	61 (19)
2007				310 (18)

This average age at the time of enrolment, represents the phenomenon of young age school leavers entrance in the medical universities of Pakistan. In the two medical universities studied there were more female students than males as shown in Fig 4.3

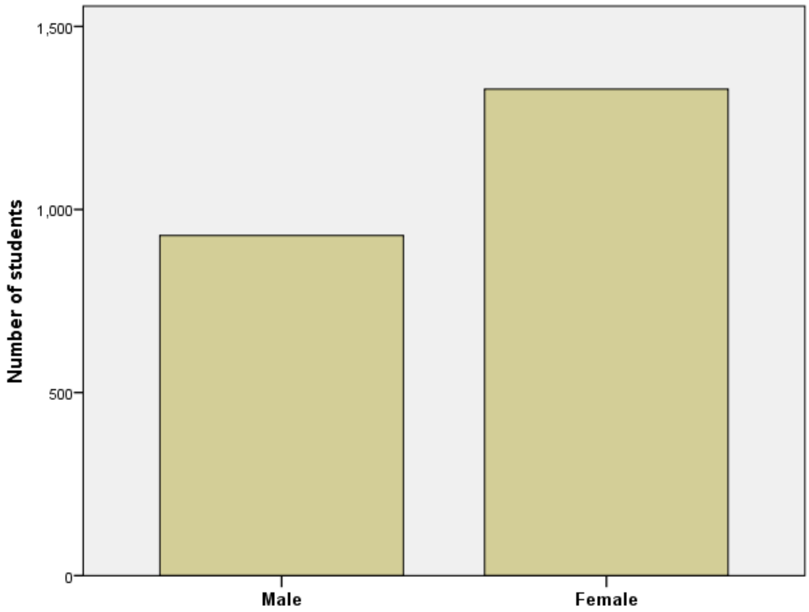


Figure 4.3 Gender distribution across two universities

The LMC is a co-education institution offering medical education to both male and female students. While the NMC is for female students only. The gender distribution at both medical universities is shown in the Table 4.2

Table: 4.2 The distribution of male and female students in two universities.

Medical university	Number of male students	Number of female students	Total
NMC	00	436	436
LMC	929	893	1822
Total	929	1329	2258

Over the period of four years, as shown in Table 4.3, the number of female students increased in the medical universities studied.

Table: 4.3 Gender distributions over four academic years.

Class Year	Male	Female	Total
2004/5	220	234	454
2005/6	253	326	579
2006/7	262	421	683
2007/8	194	348	542
Total	929	1329	2258

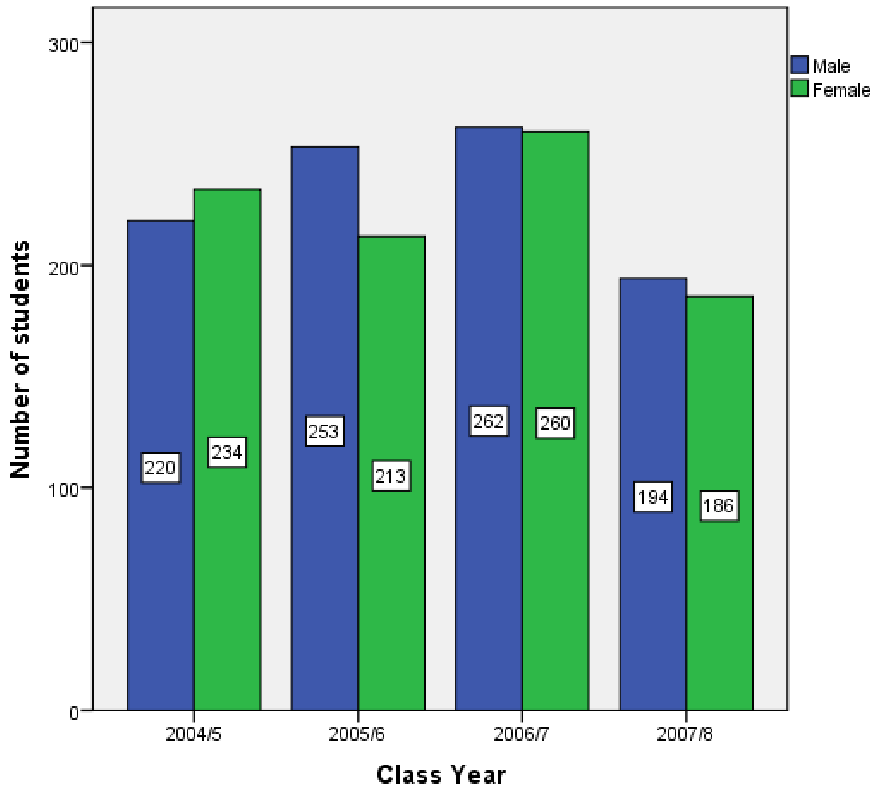


Figure: 4.4 Gender distribution in medical

Majority (96.63%) of students registered in each of the medical universities were local students, only a small percentage (03.37%) is of international students. Local students from Pakistan belong to different cities, as shown in Fig 4.5.

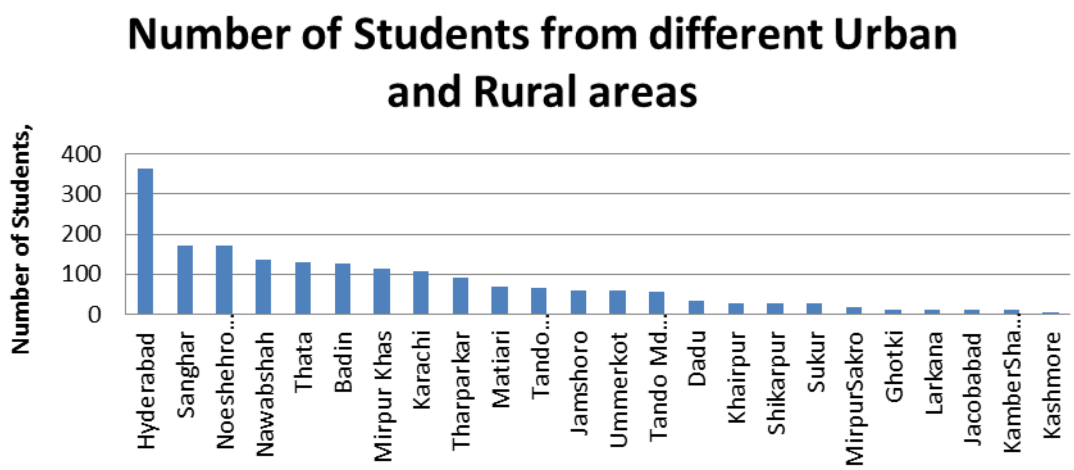


Figure: 4.5 Number of students coming from different cities of Pakistan.

Due to the location and legislative requirements, both medical universities take most of the students from the southern parts of Pakistan. Figure 4.6 and table 4.4 show the majority (75.2 %) of the students' population has a rural residential address as mentioned in their application form. Only 24.0% come from urban metropolitan settlements. Admission of the students from rural areas has been higher throughout the period studied.

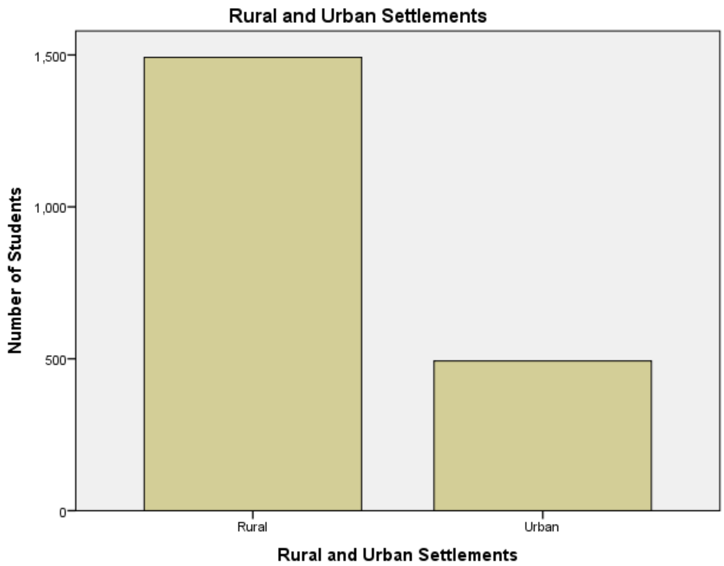


Figure: 4.6 The number of students coming from urban and rural areas.

Table:4.4 Number of Students admitted from Rural or urban settlements during different academic years.

Number of Students admitted from Rural or urban settlements during different calendar years.						
		Batch year				Total
		2004/5	2005/6	2006/7	2007/8	
Rural	Count	234	394	466	398	1492
	% within Batch year	60.3%	76.4%	79.9%	79.9%	75.2%
Urban	Count	154	122	117	100	493
	% within Batch year	39.7%	23.6%	20.1%	20.1%	24.8%
Total	Count	388	516	583	498	1985
	% within Rural and Urban Settlements	19.5%	26.0%	29.4%	25.1%	100.0%

The two medical universities admit students under different admission schemes. The two most common criteria are admission based on merit and admission based on self-financing scheme. The graph 4.7 shows the number of students admitted under these common schemes.

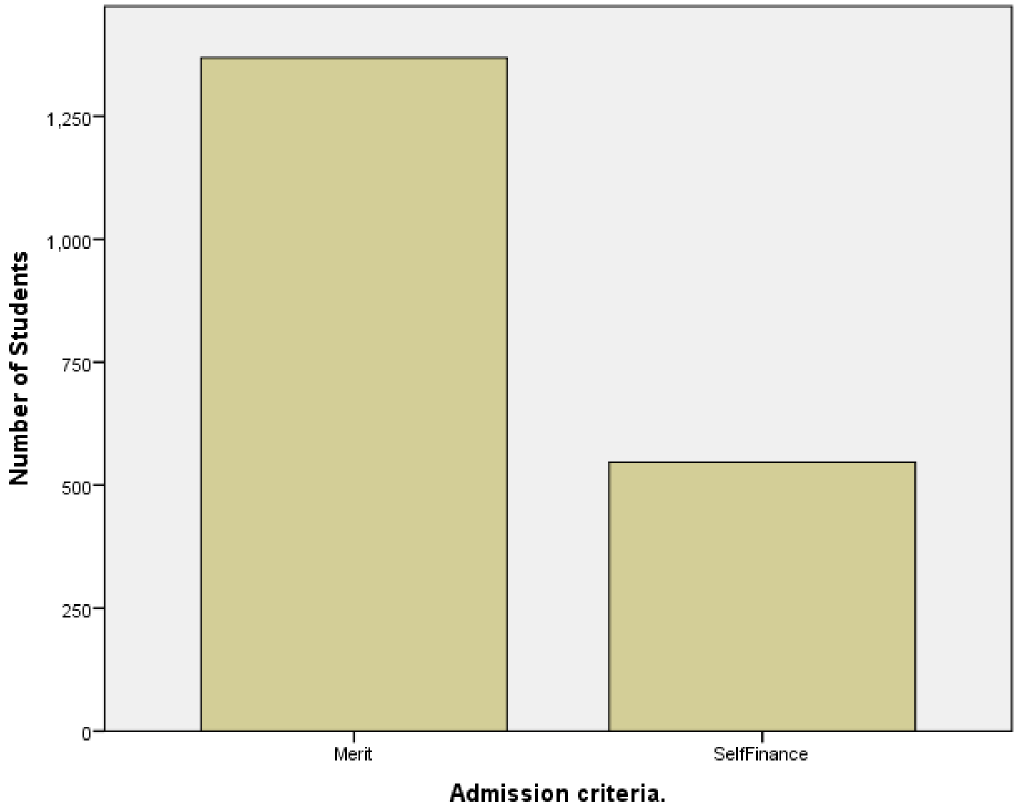


Figure: 4.7 The number of students admitted under merit and self-financing schemes of admission.

The Table 4.5 and Fig 4.8 show that the numbers of students admitted through merit scheme are increasing while the numbers of for self-financing scheme indicate a recent decline.

Table: 4.5 Number of students admitted under merit and self-financing schemes of admission during different years.

Admission Scheme		2004/5	2005/6	2006/7	2007/8	Total
Merit	Count	265	345	370	389	1369
	% within Batch year	70.1%	68.0%	67.3%	80.9%	71.5%
Self -Finance	Count	113	162	180	92	547
	%	20.7%	29.6%	32.9%	16.8%	100.0%

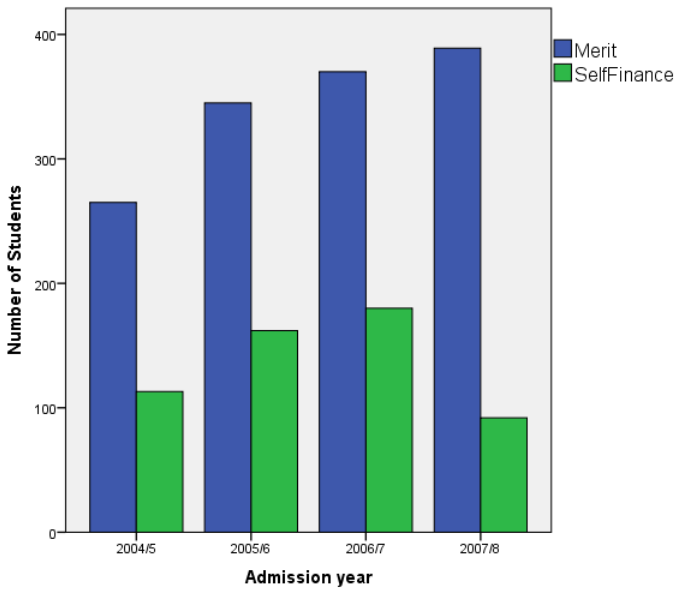
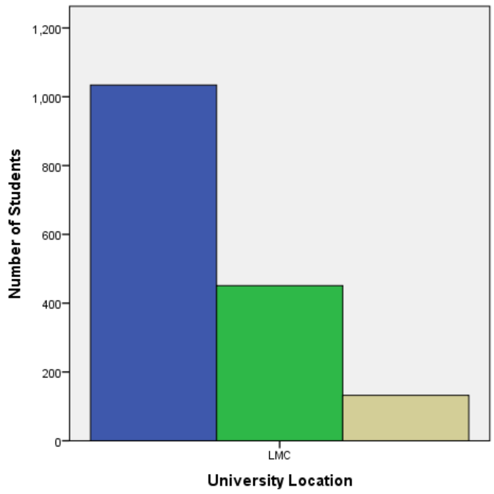


Figure: 4.8a The number of students admitted under merit and self-financing schemes of admission during different academic years.



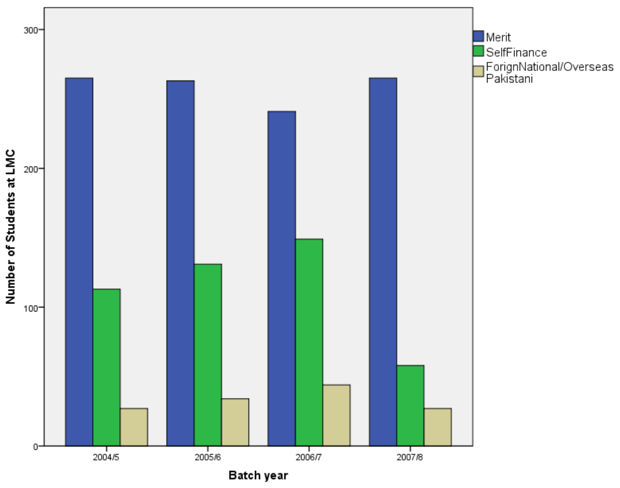


Figure: 4.8b The number of students admitted in LMC under merit and self- financing schemes of admission during different academic years.

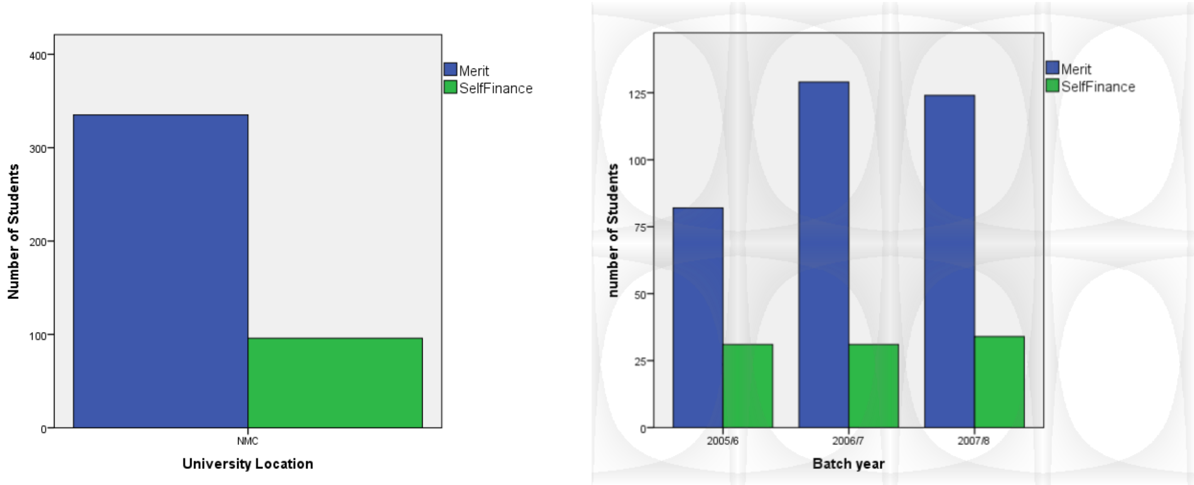


Figure: 4.8c The number of students admitted in NMC under merit and self-financing schemes of admission during different years.

The tabulation of the university, gender, admission criteria and residential address is presented in Table 4.6. The table shows that most (80%) of male students successful in getting admission based on merit belong to rural area. Approximately 20% of male students admitted on merit scheme come from urban areas. A similar trend is observed for male students admitted under self-financing scheme. In the NMC 99.1% and 94.8% of the students admitted under merit and self-financing schemes of admission schemes respectively come from rural areas. The table further shows that among female students admitted under merit scheme in the LMC, 53.1% and 46.9% of female students come from rural and urban areas respectively. However for self-financing scheme, the number of rural female students is 67.2%, twice then 32.8% from urban areas. The table further shows that almost 75.3% of the student population belong to rural settlements while only 24.7% belong to urban areas.

Furthermore, out of 1898 valid student cases, 53.8% of students admitted through merit scheme belong to the rural areas, while only 17.8% are from urban areas. Regarding self- financing scheme, 21.4% and 7.0% of students belong to rural and urban areas respectively. The table indicates that the students with a rural address securing admission based on merit criteria form a large group of student population studied.

The descriptive statistics of students' performance before and during medical education is provided in Table 4.7. Also Fig 4.10 shows multiple graphs with normality curve of the different measured variables. Most of the variables measured are normally distributed as can be observed from normality curves. Skewedness of these variables was checked and was found to be less than one. The descriptive statistics supported the use of parametric statistical techniques for further analysis.

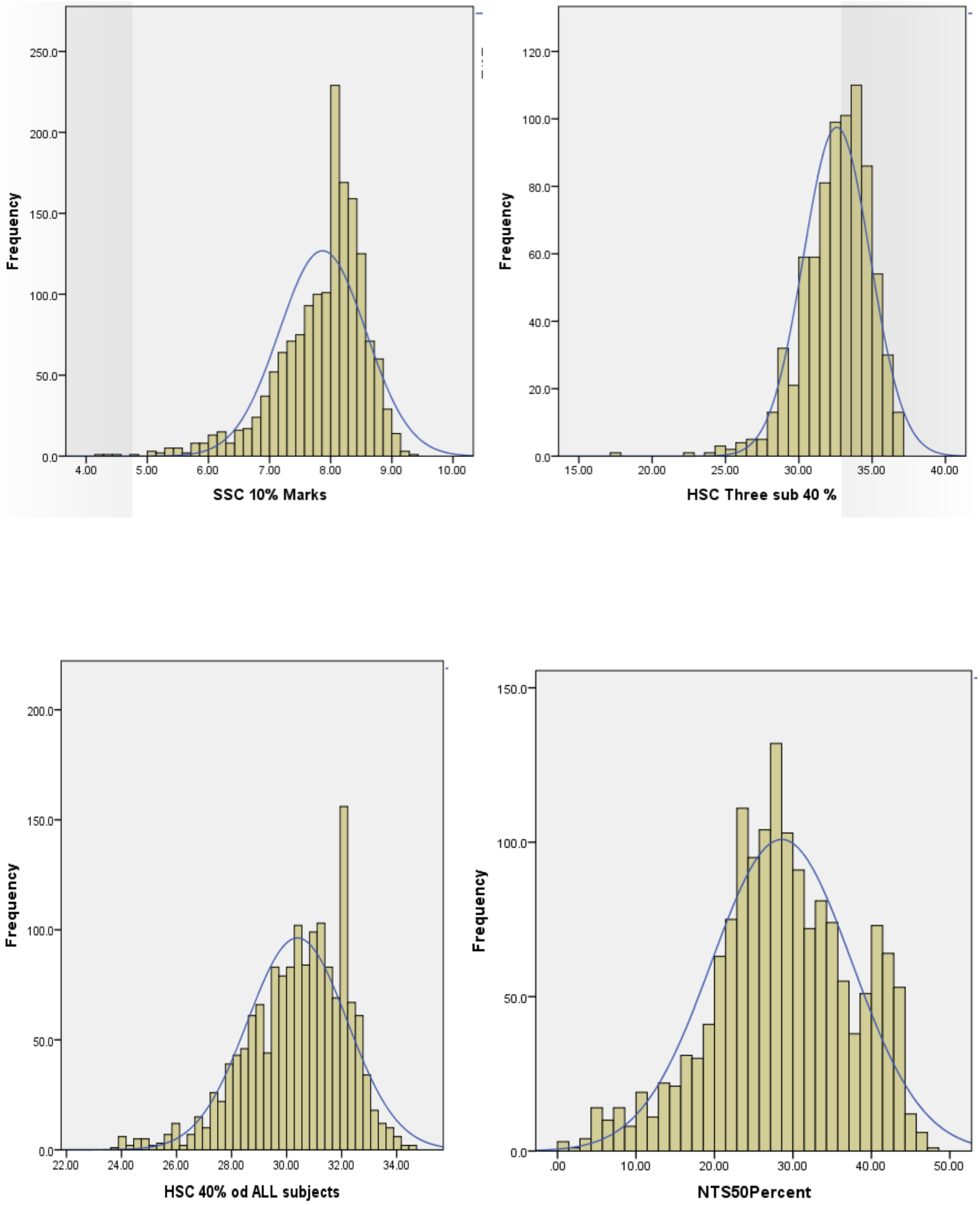
Table 4.6: The tabulation of the university, gender, admission criteria and residential address.

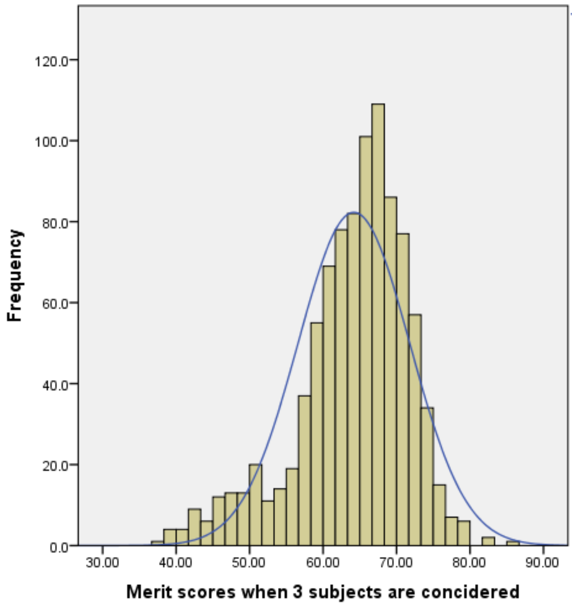
		NMC			LMC			Total		
		Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	Total
Male	Merit (N)				428	102	530	428	102	530
	%				80.8%	19.2%	100.0	80.8	19.2	100.0
	Self-Finance (N)				141	43	184	141	43	184
	%				76.6	23.4	100.0	76.6	23.4	100.0
	Total N							569	145	714
	N %							79.7	20.3	100.0
Females										
	Merit (N)	329	3	332	264	233	497	593	236	829
	%	99.1	0.9	100.0	53.1	46.9	100.0	71.5	28.5	100.0
	Self-Finance (N)	91	5	96	174	85	259	265	90	355
	%	94.8	5.2	100.0	67.2	32.8	100.0	74.6	25.4	100.0
Total	(N)							858	326	1184
	%							72.5	27.5	100.0
	Merit (N)	420			692	335	1027	1021	338	1359
	%	98.1			67.4	32.6	100.0	75.1	24.9	
	Self-Finance (N)		8		315	128	443	406	133	539
	%		1.9		71.1	28.9	100.0	75.3	24.7	
	(N)			428	1007	463	1470			
	% and (N)			100.0	68.5	31.5	100.0	1427	471	1898
	%							75.2	24.8	100.0

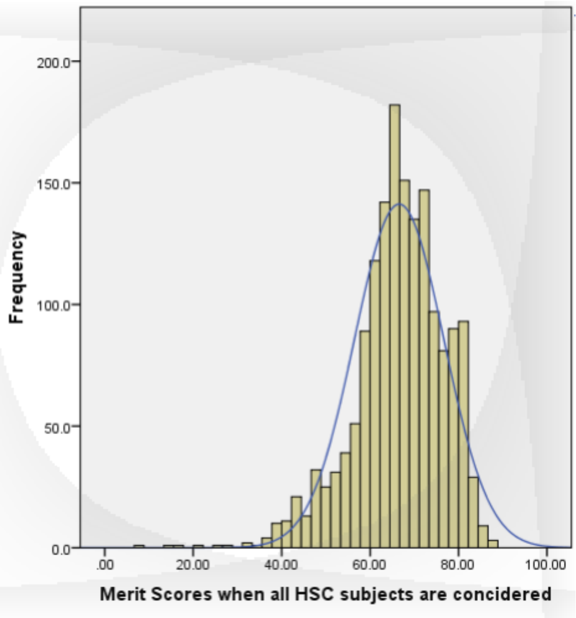
Table: 4.7 The descriptive statistics of different variables.

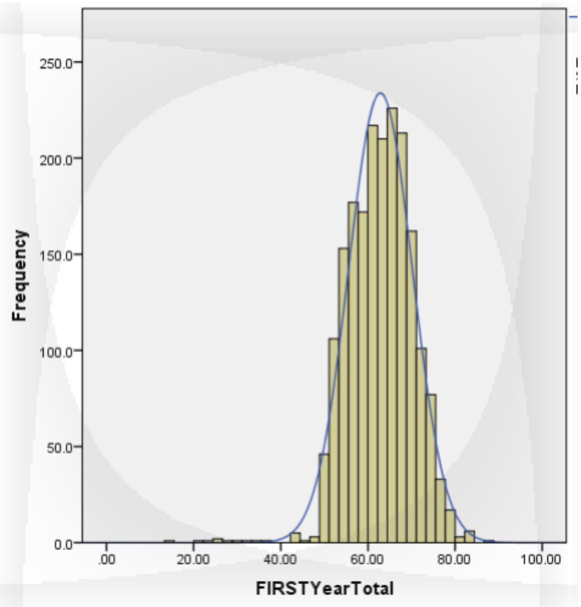
Descriptive Statistics of Different variables					
	N	Minimum	Maximum	Mean	Std. Deviation
SSC 10% Marks	1583	4.22	9.40	7.87	0.71
HSC Three sub 40 %	780	17.33	37.07	32.59	2.28
HSSC 40% of ALL subjects	1577	23.75	34.65	30.39	1.81
NTS50Percent	1583	.13	48.00	28.57	8.94
Merit scores when 3 subjects are considered	942	37.35	85.69	64.19	7.61
Merit Scores when all HSSC subjects are considered	1612	7.68	87.35	66.56	10.11
Physics Total	289	112.00	189.00	168.19	15.71
Chemistry Total	289	117.00	188.00	165.49	16.43
Biology Total	289	132.00	189.00	169.19	14.00
HSSC Science subjects Total	289	417.00	556.00	502.87	40.26
HSSC Language	774	282.00	478.00	360.15	20.79
Basic Science Theory	1969	7.23	88.29	63.23	10.13
Basic Science Practical	1969	7.71	89.41	60.45	10.40
Basic Science Total	1969	7.59	88.85	61.97	10.03
Clinical Science Theory	1960	43.40	85.28	67.76	5.72
Clinical Science Practical	1960	38.26	92.12	67.87	8.12
Clinical Science Total	1960	43.10	87.25	67.81	6.09
MBBS Theory/Knowledge Total	697	46.04	86.59	68.10	5.50
MBBS Practical and Clinical Skills Total	697	41.74	90.03	68.85	5.73
MBBS Professional Performance	1914	42.31	88.31	65.24	6.55

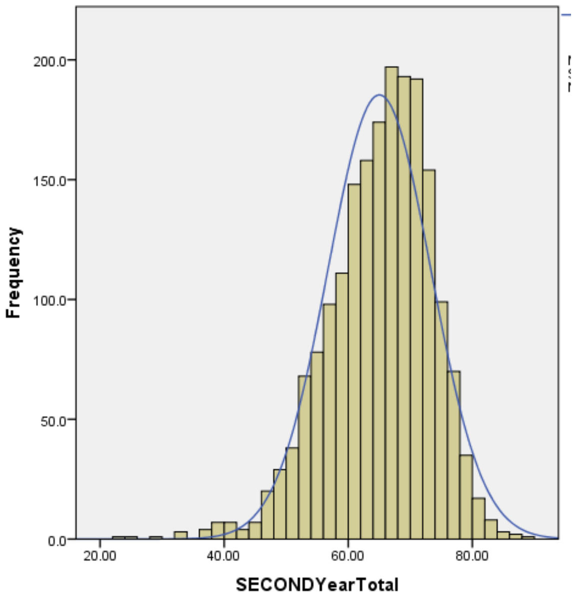
Figure: 4.9 The distribution with normality curve for assessment scores of students.

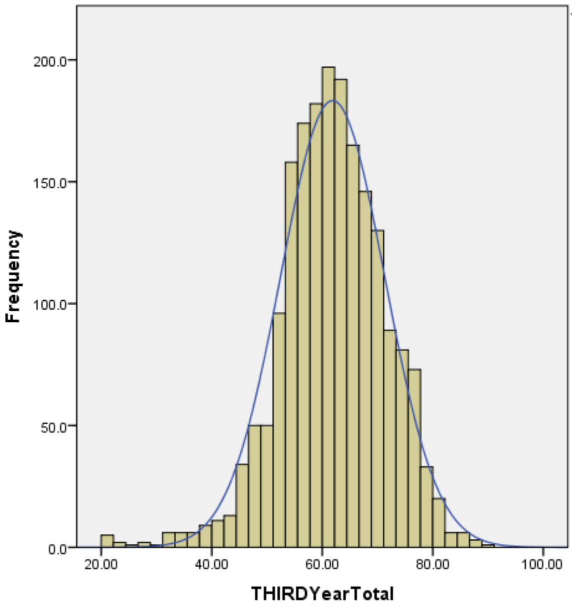



Frequency
Merit scores when 3 subjects are concidered


Frequency
Merit Scores when all HSC subjects are concidered


Frequency
FIRSTYearTotal


Frequency
SECONDYearTotal


Frequency
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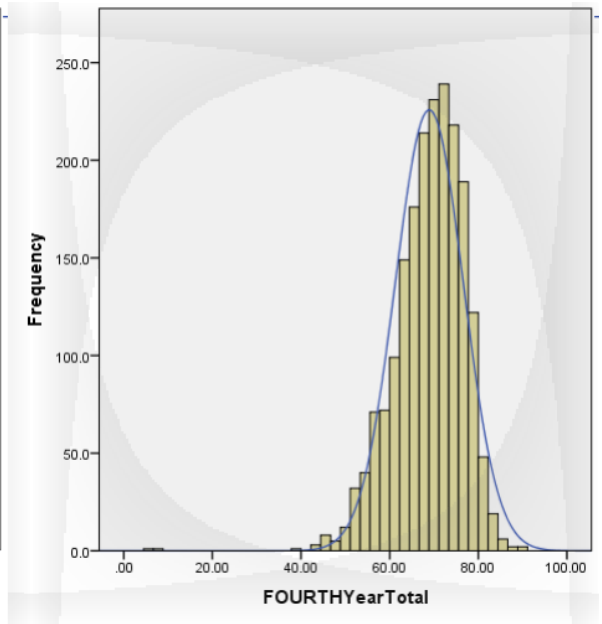
60.00
80.00
100.00


Frequency
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150.0
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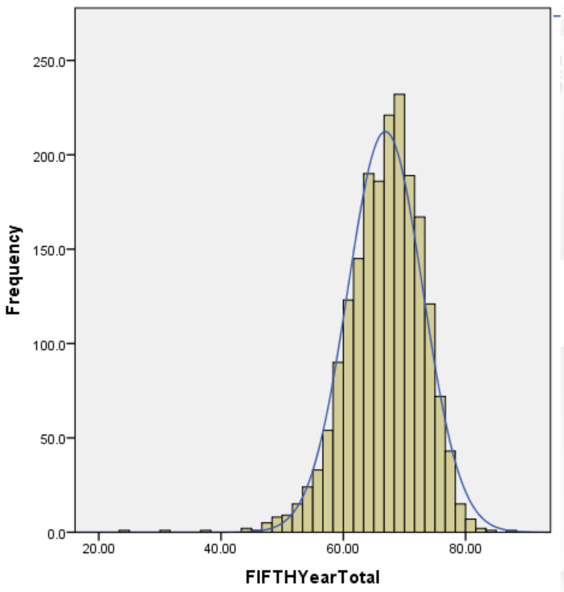
.00
20.00
40.00
60.00
80.00
100.00


Frequency
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40.00
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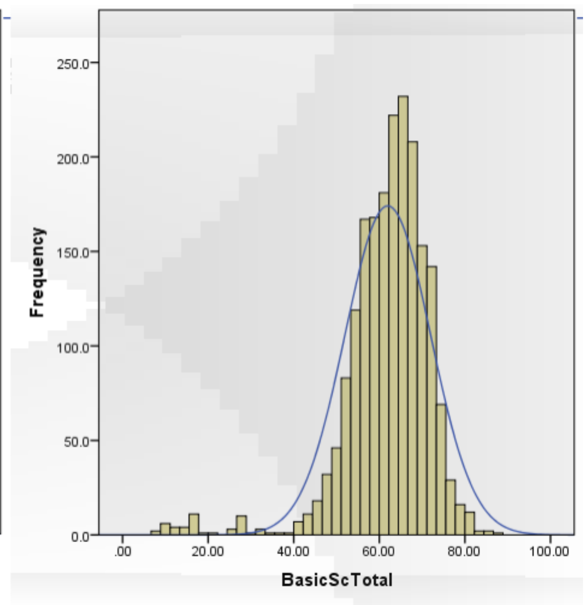
80.00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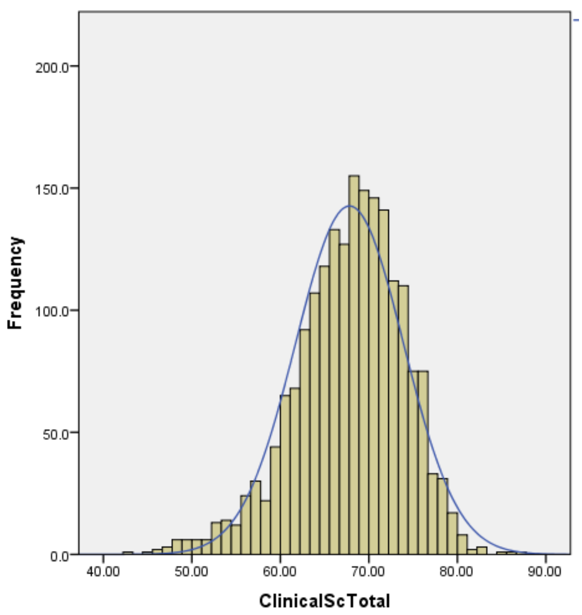
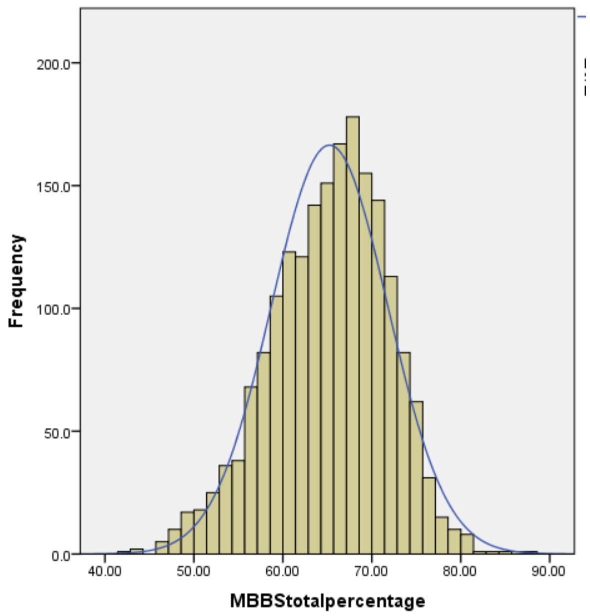




SECTION-II

Comparing premedical university mean scores between different groups.

Although the data set has students' achievement scores of various examinations, for the purpose of this study the premedical university scores i.e. SSC grade X, HSSC grade XII science and language subjects and entrance test scores, and undergraduate medical education scores i.e. basic sciences scores, clinical science scores and MBBS total scores as outcome variable scores were analysed. Comparisons were based on gender, location of the universities, admission scheme, residential category, closeness to the university from home address, and the year of admission.

The Table 4.8 shows the performance of local male and female students in pre medical education scores in SSC grade X, HSSC grade XII, University Entrance Test conducted by NTS, combined admission scores when grade X and NTS scores are added with the scores of three science subjects i.e. biology, physics and chemistry, and combined admission scores when SSC grade X and NTS scores are added with the scores of three science subjects and language subjects i.e. English and Urdu or Sindhi.

The Table 4.8 shows that the academic performance of female students was statistically significantly better than male students in SSC grade X assessment (t (1567) = -6.99, p <.001). Females scored (M = 7.97, SD = 0.68) higher than males (M = 7.72, SD = 0.73). Similarly female students scored statistically significantly higher than male students in the cumulative scores of all HSSC subjects' assessment: t = (1396.01) = -5.21, p <.001. Females scored (M = 30.60, SD = 1.76) higher than males (M =

30.12, *SD* = 1.85). In other pre-university variables there were no significant differences in achievement of female and male students. However, as presented in table 4.9, during medical education assessments the mean scores of female students were statistically significantly higher than male students.

While there were no differences observed in the mean scores between male and female students in pre-university school achievements, the differences observed between the two sexes were statistically significant during medical education achievements. The female students consistently performed statistically significantly higher than male students throughout medical education as seen in Table 4.9. The performance of female students as compared to male students in the LMC, having a mixed male and female intake of students, showed the same statically significantly higher performance of female students as shown in table 4.9a. Furthermore the academic performance of female students in NMC is statistically significantly higher than female students in LMC as shown in table 4.9b. Regardless of the differences in demographic variables as shown table 4.9c, the performance of female students remained statistically significantly higher than male students during medical education.

The independent sample *t* test comparing students at NMC and LMC presented in Table 4.10, suggests that across all variables there were statistically significant differences between the student groups, except achievement in HSSC grade XII three science subjects cumulative score: *t* (292.046) = 0.143, *p* = 0.88 and clinical sciences' theory component: *t* (658.225) = 0.236, *p* = 0.814. The scores of NMC (*M* = 32.57, *SD* = 1.69) and LMC (*M* = 32.60, *SD* = 2.39) for 40% HSSC three sciences subjects were not statistically significant: *t* (292.046) = 0.143, *p* = 0.88. The scores in clinical sciences' theory were also not statistically significant for NMC (*M* = 67.70, *SD* = 4.97) and from LMC (*M* = 67.77, *SD* = 5.89) with *t* (658.225) = 0.236, *p* = 0.814. In pre medical assessments the students at LMC performed consistently higher than the students registered in NMC. The students of LMC also performed better in the two different methods of calculation of final admission scores. Students of NMC (*M* = 8.05, *SD* 0.52) performed higher than LMC (*M* = 7.84, *SD* =0.73) in SSC grade X achievement scores only: *t* (386.126) = - 5.268, *p* = <.001. The mean achievement scores of two groups in three science subjects of HSSC grade XII were not different at statistically significant level. Hence, the overall performance of students admitted in LMC was better than students admitted in NMC in premedical assessment scores considered for the admission. However as seen in Table 4.9, the students of NMC achieved statistically significant higher mean scores than LMC in almost all assessments except theory component of clinical sciences during medical education. The methods of assessment and the course contents covered in the assessment at these two universities are similar. Also the standards of assessment are also similar. This is because most of the public universities of Pakistan are guided by the PMDC regulation regarding curriculum contents and assessment. Due to similarity in course contents, assessment methods and standards, students can transfer from one university to another and get the same credit of prior learning. Further analysis of achievement of students admitted in two different universities on two different admission criteria is presented in table 4.10a. It shows that high achieving meritorious students having statistically significant higher pre-entry scores chose LMC. While high achieving full fee-paying students chose NMC. In both scenarios students of NMC performed statistically significantly higher than LMC students during five years of medical education.

The residential address mentioned by students as their home town in the admission application form was considered to calculate the travel distance from the university where the students were registered. Then the students were divided in two groups i.e. coming from closer areas and far areas, based on the distance from the university. The NMC is not located in a metropolitan area while LMC is located close to a metropolitan region. As shown in figure 4.5 number students come from different cities located at various distances from two universities. The academic performance of students in pre-university assessments, NTS and during medical universities shown in Table 4.11 was not significantly different except mean scores in physics. The mean score in physics for the students coming from closer areas to university was (M = 171.16, SD = 11.26) higher than students coming from far distance (M = 164.86, SD = 19.04) with t (287) = 3.466, $p < 0.001$.

Table:4.8 Independent sample *t* test comparing the mean scores of Pakistan origin male and female students achieved before entering medical universities.

	Gender	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
SSC 10% Marks	Male	671	7.72	0.73	-6.99	1567	.00
	Female	898	7.97	0.68			
HSSC Three sub 40 %	Male	310	32.45	2.44	-1.54	765	.12
	Female	457	32.71	2.16			
HSSC 40% of ALL subjects	Male	668	30.12	1.85	-5.21	1396.01	.00
	Female	895	30.60	1.76			
NTS50Percent	Male	671	29.07	9.17	1.68	1567	.09
	Female	898	28.30	8.74			
Merit scores when 3 subjects are considered	Male	307	64.45	7.96	.61	922	.54
	Female	617	64.12	7.34			
Merit Scores when all HSSC subjects are considered	Male	672	66.75	10.25	.42	1596	.67
	Female	926	66.53	10.01			
Physics Total	Male	144	168.38	12.53	.20	287	.84
	Female	145	168.01	18.37			
Chemistry Total	Male	144	164.90	13.27	-.60	287	.54
	Female	145	166.07	19.09			
Biology Total	Male	144	167.97	10.05	-1.48	287	.13
	Female	145	170.41	17.00			
HSSC Science subjects Total	Male	144	501.25	27.32	-.68	287	.49
	Female	145	504.48	49.95			
HSSC Language	Male	307	357.54	21.30	-1.44	761	.15
	Female	456	360.50	31.37			

Table 4.11further shows that coming from different distances to the university did not affect the students' achievement in university entrance test and the performance during medical education.

Table: 4.9 Independent sample *t test* comparing the mean scores of all male and female students achieved during medical education.

	Gender	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
FIRST Year Total	Male	779	61.32	7.11	-7.71	1937	.00
	Female	1160	63.90	7.33			
SECOND Year Total	Male	779	63.20	8.38	-8.07	1926	.00
	Female	1149	66.26	8.01			
THIRD Year Total	Male	789	59.25	8.87			
	Female	1159	63.65	9.37	-10.52	1752.05	.00
FOURTH Year Total	Male	793	67.58	7.56	-6.45	1958	.00
	Female	1167	69.84	7.65			
FIFTH Year Total	Male	793	66.33	5.67			
	Female	1166	67.24	6.41	-3.30	1827.48	.00
Basic Sc Theory	Male	795	62.11	9.56	-4.06	1967	.00
	Female	1174	63.99	10.44			
Basic Sc Practical	Male	795	57.62	10.15	-10.21	1967	.00
	Female	1174	62.37	10.13			
Basic Sc Total	Male	795	59.98	9.57	-7.35	1967	.00
	Female	1174	63.32	10.10			
Clinical Sc Theory	Male	793	68.46	5.27			
	Female	1167	67.28	5.97	4.64	1829.93	.00
Clinical Sc Practical	Male	793	65.30	7.98	-11.93	1958	.00
	Female	1167	69.61	7.74			
Clinical Sc Total	Male	793	66.88	5.66			
	Female	1167	68.44	6.29	-5.71	1812.74	.00
MBBS Theory Total	Male	158	67.12	6.28			
	Female	539	68.39	5.23	-2.31	224.514	.02
MBBS Practical Skills Total	Male	158	67.41	6.18	-3.63	695	.00
	Female	539	69.27	5.53			
MBBS Professional Performance	Male	772	63.68	6.27	-8.76	1912	.00
	Female	1142	66.30	6.53			

Table: 4.9a Independent sample *t Test* comparing the mean scores of male and female students at LMC achieved during medical education.

Variable	sex	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Basic Science Total	Male	795	59.98	9.57	-4.64	1575	.00
	Female	782	62.21	9.46			
Clinical Science Total	Male	793	66.88	5.66	-2.97	1579	.00
	Female	788	67.82	6.81			
MBBS Professional Performance	Male	772	63.68	6.27	-4.92	1535	.00
	Female	765	65.34	6.99			

Table: 4.9b Independent sample t test *comparing the* mean scores of female students at NMC and LMC achieved during medical education.

	University	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
MBBS Professional Performance	LMC	765	65.34	6.99	-7.218	1140	.00
	NMC	377	68.24	4.93			

Table: 4.9c Independent sample *t test* comparing the mean scores of male and female students with different demographic variables during medical education.

MBBS Professional Performance of students		N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
living closer to uni	Male	319	64.04	6.30	-5.12	892	.00
	Female	575	66.33	6.48			
living away from uni	Male	353	63.86	6.17	-6.60	878	.00
	Female	527	66.70	6.33			
rural settlements	Male	542	63.76	5.94	-8.26	1335	.00
	Female	795	66.57	6.26			
urban settlements	Male	136	64.67	7.24	-2.35	444	.01
	Female	310	66.34	6.76			
Admitted on merit	Male	492	65.14	5.80	-10.67	1250	.00
	Female	760	68.51	5.25			
Admitted on self-financing	Male	159	60.38	6.37	-2.46	473	.01
	Female	316	61.91	6.41			

As seen in Fig 4.5 students come from different cities in Pakistan. Among the different cities, only two cities namely Karachi and Hyderabad are classified as major urban metropolitan cities of Pakistan. Hence, for the purpose this study, these two cities are considered as urban metropolitan areas while the remaining cities as non-urban non metropolitan rural areas. The *t* statistics in table 4.12 demonstrate that there are statistically significant differences in the scores of SSC grade X, university entrance test, admission scores when all HSSC subjects (science and language) are considered and clinical sciences theory component of medical education. In SSC grade X, the mean scores of students from urban areas (M = 7.95, SD = 0.72) is higher than students from rural areas (M = 7.84, SD = 0.71) with t (1567) = -2.586, p <0.01. The mean scores in university entrance test for students from urban settlements (M =30.68, SD=10.08) is higher than the students from rural areas (M= 27.97, SD = 8.43) with t (560.791) = -4.73, p < 0.001. The students from the urban areas also achieved (M = 68.84, SD = 11.80) higher admission scores when all HSSC subjects were considered for admission than the student from rural areas with (M = 65.92, SD = 9.41) scores with t (545.5) = -4.433, p < 0.001. During medical education the only significant difference observed was in clinical sciences theory component with urban students (M = 68.50, SD = 5.97) performing higher than rural students (M = 67.73, SD = 5.49) with t (715.368) = -2.424, p < .05.

As mentioned previously, students were admitted to the medical universities of Pakistan based on different admission criteria. As presented in Table 4.13 the students admitted under merit scheme criteria achieved statistically significant higher mean scores in all premedical school achievements, NTS entrance test scores and assessments during medical education. The most significant difference in the mean scores between the groups is observed in NTS and combined scores for the admission in the university. The data also show that the inclusion of language subjects in the total calculation for determining the score for admission has further improved the scores for high achieving students admitted based on merit than low achievers who were admitted under self-financing scheme criteria. The data further show that the high achieving students admitted on the basis of merit also achieve significantly higher mean scores during medical education.

Table:4.10 Independent Samples *t test* comparing students' achievements at two different universities.

University Location		N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
SSC 10% Marks	LMC	1359	7.84	0.73	-5.26	386.12	.00
	NMC	224	8.05	0.52			
HSSC Three sub 40 %	LMC	635	32.60	2.39	.14	292.04	.88
	NMC	145	32.57	1.69			
HSSC 40% of ALL subjects	LMC	1353	30.36	1.88	-2.52	379.88	.01
	NMC	224	30.62	1.36			
NTS50Percent	LMC	1359	28.90	9.39	5.60	521.46	.00
	NMC	224	26.53	5.05			
Merit scores when 3 subjects are considered	LMC	635	64.47	8.44	1.90	862.94	.05
	NMC	307	63.60	5.48			
Merit Scores when all HSSC subjects are considered	LMC	1363	66.86	10.71	4.17	630.18	.00
	NMC	249	64.93	5.65			
Physics Total	LMC	289	168.19	15.71			
	NMC	0^a					
Chemistry Total	LMC	289	165.49	16.43			
	NMC	0^a					
Biology Total	LMC	289	169.19	14.00			
	NMC	0^a					
HSSC Language	LMC	632	357.53	32.88	-3.58	477.68	.00
	NMC	145	364.12	15.52			
HSSC Science subjects Total	LMC	289	502.87	40.26			
	NMC	0^a					
FIRST Year Theory	LMC	325	64.19	7.95	-4.13	703.41	.00
	NMC	392	66.72	8.43			
FIRST Year Practical	LMC	325	65.27	6.86	4.08	713.59	.00
	NMC	392	62.91	8.65			
FIRST Year Total	LMC	1547	62.37	7.07	-5.47	552.05	.00
	NMC	392	64.81	8.08			
SECOND Year Theory	LMC	1547	64.97	9.53	-11.65	751.83	.00
	NMC	381	70.08	7.13			
SECOND Year Practical	LMC	1547	63.30	8.86	-8.72	679.60	.00
	NMC	381	67.13	7.35			
SECOND Year Total	LMC	1547	64.14	8.42	-11.05	707.02	.00
	NMC	381	68.61	6.70			

THIRD Year Theory	LMC	1569	62.41	9.03	-12.62	707.47	.00
	NMC	379	67.82	7.07			
THIRD Year Practical	LMC	1569	58.49	10.52	-19.54	671.66	.00
	NMC	379	68.64	8.70			
THIRD Year Total	LMC	1569	60.34	9.23	-17.80	699.04	.00
	NMC	379	68.21	7.32			
FOURTH Year Theory	LMC	1581	67.11	6.90	-3.04	704.32	.00
	NMC	379	68.11	5.42			
FOURTH Year Practical	LMC	1581	69.63	11.01	-10.45	877.09	.00
	NMC	379	74.40	7.05			
FOURTH Year Total	LMC	1581	68.37	8.02	-8.22	797.83	.00
	NMC	379	71.25	5.58			
FIFTH Year Theory	LMC	1581	67.90	6.27	1.89	1957	.05
	NMC	378	67.22	6.29			
FIFTH Year Practical	LMC	1581	65.39	8.14	-6.61	1957	.00
	NMC	378	68.40	7.25			
FIFTH Year Total	LMC	1581	66.64	6.20	-3.34	1957	.00
	NMC	378	67.81	5.76			
Basic Sciences Theory	LMC	1577	62.40	9.72	-7.37	1967	.00
	NMC	392	66.56	11.05			
Basic Sciences Practical	LMC	1577	59.43	9.93	-8.95	1967	.00
	NMC	392	64.58	11.19			
Basic Sciences Total	LMC	1577	61.08	9.58	-8.95	1967	.00
	NMC	392	65.55	10.95			
Clinical Sciences Theory	LMC	1581	67.77	5.89	.23	658.22	.81
	NMC	379	67.70	4.97			
Clinical Sciences Practical	LMC	1581	66.93	8.31	-13.30	796.37	.00
	NMC	379	71.77	5.80			
Clinical Sciences Total	LMC	1581	67.35	6.27	-8.15	723.17	.00
	NMC	379	69.74	4.79			
MBBS	LMC	1537	64.51	6.69	-12.22	755.51	.00
	NMC	377	68.24	4.93			

Table:4.10a Independent Samples *t* Test comparing achievements of students admitted on the merit and self-financing criteria in two different universities.

	Achievement	Universities	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Student admitted on merit criteria	NTS50Percent	LMC	920	33.01	6.71	13.29	1127	.00
		NMC	209	26.43	5.18			
	Merit scores when 3 subjects are considered	LMC	431	68.84	4.14	11.34	674	.00
		NMC	245	64.98	4.46			
	Merit Scores when all HSSC subjects are considered	LMC	922	71.84	6.87	12.79	1136	.00
		NMC	216	65.47	5.19			
	MBBS Professional Performance	LMC	954	66.57	5.91	-7.02	1250	.00
		NMC	298	69.18	4.52			
Students admitted on Self-finance criteria	NTS50Percent	LMC	422	20.34	8.16	-2.40	136.88	.01
		NMC	11	27.92	2.16			
	Merit scores when 3 subjects are considered	LMC	195	55.31	7.78	-2.90	35.34	.00
		NMC	57	57.44	5.19			
	Merit Scores when all HSSC subjects are considered	LMC	424	56.47	9.67	.54	485	.58
		NMC	29	60.57	7.18			
	MBBS Professional Performance	LMC	396	60.73	6.51	-5.16	473	.00
		NMC	79	64.72	4.84			

Table: 4.11 Independent sample *t test* comparing the mean scores of students coming from township close or away from universities.

Closeness to Uni location		N	Mean	Std. Deviation n	t	df	Sig. (2-tailed)
SSC 10% Marks	Close to uni	869	7.89	0.72	1.17	1566	.24
	Away from uni	699	7.84	0.70			
HSSC Three sub 40 %	Close to uni	423	32.64	2.29	.44	765	.65
	Away from uni	344	32.56	2.26			
HSSC 40% of ALL subjects	Close to uni	865	30.42	1.78	.58	1560	.55
	Away from uni	697	30.37	1.86			
NTS50Percent	Close to uni	869	28.44	8.97	-.93	1566	.34
	Away from uni	699	28.86	8.89			
Merit scores when 3 subjects are considered	Close to uni	464	64.09	7.84	-.57	922	.56
	Away from uni	460	64.37	7.25			
Merit Scores when all HSSC subjects are considered	Close to uni	883	66.32	10.46	-1.31	1595	.19
	Away from uni	714	66.99	9.66			
Chemistry Total	Close to uni	153	165.06	12.83	-.47	287	.63
	Away from uni	136	165.97	19.75			
Biology Total	Close to uni	153	170.05	9.75	1.10	287	.27
	Away from uni	136	168.23	17.59			
Physics Total	Close to uni	153	171.16	11.26	3.46	287	.00
	Away from uni	136	164.86	19.04			
HSSC Science Subjects Total	Close to uni	153	506.26	26.46	1.52	287	.12
	Away from uni	136	499.06	51.40			
HSSC Language	Close to uni	419	360.29	21.12	1.08	761	.28
	Away from uni	344	358.11	34.19			
FIRST Year Total	Close to uni	903	63.22	7.12	.51	1793	.60
	Away from uni	892	63.04	7.40			
SECOND Year Total	Close to uni	900	65.51	8.05	.52	1782	.59
	Away from uni	884	65.30	8.11			
THIRD Year Total	Close to uni	896	62.51	8.93	-.28	1776	.77
	Away from uni	882	62.63	8.87			
FOURTH Year Total	Close to uni	898	69.22	7.43	-.51	1777	.60
	Away from uni	881	69.40	7.20			

FIFTH Year Total	Close to uni	898	67.11	5.94	-.34	1778	.73
	Away from uni	882	67.21	6.04			
Basic Sciences Theory	Close to uni	903	64.29	8.53	.64	1793	.52
	Away from uni	892	64.02	9.24			
Basic Sciences Practical	Close to uni	903	61.55	9.03	.71	1793	.47
	Away from uni	892	61.23	9.68			
Basic Sciences Total	Close to uni	903	63.14	8.01	.68	1793	.49
	Away from uni	892	62.87	8.88			
Clinical Sciences Theory	Close to uni	899	67.77	5.78	-1.13	1779	.25
	Away from uni	882	68.08	5.46			
Clinical Sciences Practical	Close to uni	899	68.25	7.97	-.37	1779	.70
	Away from uni	882	68.40	7.96			
Clinical Sciences Total	Close to uni	899	68.01	6.03	-.78	1779	.43
	Away from uni	882	68.24	5.88			
MBBS	Close to uni	894	65.51	6.51	-.15	1772	.87
	Away from uni	880	65.56	6.41			

Table: 4.12 Group Statistics of students coming from Urban and Rural areas.

	Urban Or Rural	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
SSC 10% Marks	Rural	1187	7.84	0.71	-2.58	1567	0.01
	Urban	382	7.95	0.72			
HSSC Three sub 40 %	Rural	625	32.52	2.27	-2.051	765	0.04
	Urban	142	32.96	2.28			
HSC 40% of ALL subjects	Rural	1182	30.35	1.81	-1.701	1561	0.09
	Urban/	381	30.53	1.84			
NTS50Percent	Rural	1188	27.97	8.43	-4.73	560.79	0.00
	Urban	381	30.68	10.08			
Merit scores when 3 subjects are considered	Rural	780	64.06	7.22	-1.34	177.60	0.18
	Urban	144	65.14	9.11			
Merit Scores when all HSSC subjects are considered	Rural	1214	65.92	9.41	-4.43	545.5	0.00
	Urban	384	68.84	11.80			
Physics Total	Rural	228	167.81	12.28	-0.8	287	0.43
	Urban	61	169.62	24.72			
Chemistry Total	Rural	228	165.88	13.62	0.77	287	0.44
	Urban	61	164.03	24.31			
Biology Total	Rural	228	168.54	10.12	-1.52	287	0.13
	Urban	61	171.61	23.38			
HSSC Language	Rural	621	359.41	25.26	0.2	761	0.84
	Urban	142	358.89	36.97			
Basic Sciences Theory	Rural	1357	64.11	9.07	-0.23	1803	0.81
	Urban	448	64.23	8.26			
Basic Sciences Practical	Rural	1357	61.20	9.56	-1.43	1803	0.15
	Urban	448	61.93	8.66			
Basic Sciences Total	Rural	1357	62.85	8.66	-1.18	1803	0.24
	Urban	448	63.40	7.74			
Clinical Sciences Theory	Rural	1343	67.73	5.49	-2.42	715.36	0.02

	Urban	448	68.50	5.97			
Clinical Sciences Practical	Rural	1343	68.23	7.95	-0.85	1789	0.39
	Urban	448	68.60	7.96			
Clinical Sciences Total	Rural	1343	67.98	5.82	-1.76	1789	0.08
	Urban	448	68.55	6.31			
MBBS	Rural	1337	65.43	6.28	-1.13	1781	0.25
	Urban	446	65.83	6.94			

Table 4.14 shows the mean scores achieved by batches of students admitted in different calendar years of admission. ANOVA was carried out to compare the group mean scores of achievements by different batches students admitted in different years. This test was found to be statistically significant at an alpha level of 0.5. The F(df) and *p* values of different variables are given the table 4.14. Statistical significance was found between all comparator groups. Both LSD and Tukey's HSD post hoc analysis showed the mean scores between batch of 2004/5 and 2005/6 for SSC 10% and HSSC 40% of all subjects were not significantly different. The difference of admission scores when all subjects were considered was also not significant between 2005/6 and 2007/8 batches. The two batches of 2005/6 and 2006/7 also did not show any significant difference in basic and clinical sciences achievement. Also the difference of means between these two batches was small for MBBS total achievement. It is observed in the different means plots in Fig 4.11 that the achievement scores show varying trends across different batches. While the achievement scores in SSC and HSSC assessments and scores in medical education show an increasing trend, the university entrance test performance shows a decreasing trend in scores achieved. As the entrance test scores are decreasing, the total merit scores show a decreasing trend till 2006/7 batch, and then after that an increase. This increase coincides with the timings when only three science subjects of HSSC were considered for the computation of final admission scores. Also during the same time there is observed an improvement in the candidates' performance in entrance test scores.

Table 4.13 Independent sample *t Test* comparing the mean scores of students admitted based on different selection criteria.

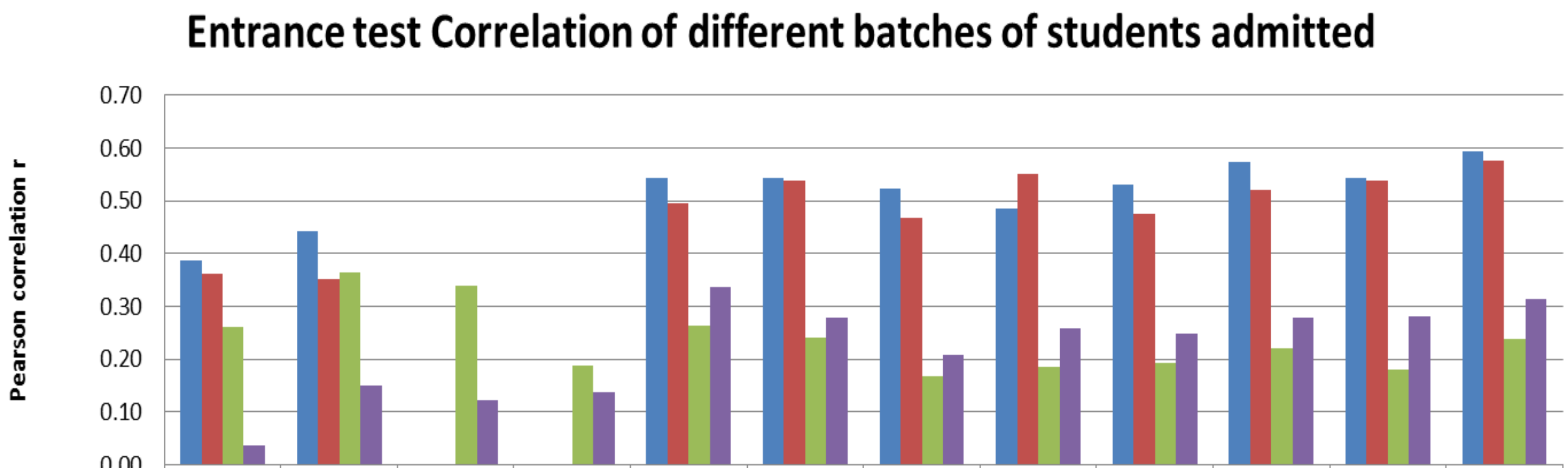
Admission criteria. 1= Merit, 2= Self-Finance		N	Mean	SD	t	df	Sig. (2-tailed)
SSC 10% Marks	Merit	1129	8.04	0.58	13.53	595.90	.00
	Self-Finance	433	7.44	0.84			
HSSC Three sub 40 %	Merit	576	33.16	1.81	10.74	253.31	.00
	Self-Finance	193	30.93	2.68			
HSSC 40% of ALL subjects	Merit	1129	30.85	1.49	14.83	606.59	.00
	Self-Finance	427	29.25	2.04			
NTS50Percent	Merit	1129	31.79	6.94	25.42	685.50	.00
	Self-Finance	433	20.53	8.15			
Merit scores when 3 subjects are considered	Merit	676	67.44	4.65	23.55	329.24	.00
	Self-Finance	252	55.79	7.32			
Merit Scores when all HSSC subjects are considered	Merit	1138	70.64	7.04	28.02	655.44	.00
	Self-Finance	453	56.73	9.58			
Chemistry Total	Merit	230	167.13	16.65	3.22	284	.00
	Self-Finance	56	159.36	14.15			
Biology Total	Merit	230	170.18	14.50	2.03	284	.04
	Self-Finance	56	165.96	10.99			
Physics Total	Merit	230	169.57	15.53	2.64	284	.00
	Self-Finance	56	163.48	15.16			
HSSC Science subjects Total	Merit	230	506.88	41.59	3.06	284	.00
	Self-Finance	56	488.80	29.69			
HSSC Language	Merit	578	361.27	28.29	3.48	763	.00
	Self-Finance	187	353.19	24.96			
FIRST Year Total	Merit	1261	64.89	6.67	16.77	1746	.00
	Self-Finance	487	58.86	6.89			
SECOND Year Total	Merit	1260	67.36	7.19	16.38	773.58	.00
	Self-Finance	477	60.41	8.14			
THIRD Year Total	Merit	1256	64.58	8.27	15.41	1729	.00
	Self-Finance	475	57.61	8.67			
FOURTH Year Total	Merit	1256	70.77	6.46	12.92	727.67	.00
	Self-Finance	476	65.52	7.92			
FIFTH Year Total	Merit	1257	68.34	5.55	12.88	788.11	.00
	Self-Finance	476	64.20	6.12			
Basic Sciences Theory	Merit	1261	66.46	7.38	16.39	705.36	.00
	Self-Finance	487	58.37	9.88			

Basic Sciences Practical	Merit	1261	63.44	7.83	13.02		
	Self-Finance	487	56.38	10.93		687.19	.00
Basic Sciences Total	Merit	1261	65.13	7.03	15.55		
	Self-Finance	487	57.73	9.55		698.58	.00
Clinical Sciences Theory	Merit	1258	69.03	4.91	12.90		
	Self-Finance	476	64.96	6.20		712.17	.00
Clinical Sciences Practical	Merit	1258	69.91	7.30	12.45		
	Self-Finance	476	64.50	8.33		766.20	.00
Clinical Sciences Total	Merit	1258	69.47	5.28	14.64		
	Self-Finance	476	64.73	6.27		743.11	.00
MBBS	Merit	1252	67.19	5.71	17.21		
	Self-Finance	475	61.40	6.43		774.49	.00

Table: 4.14 Descriptive statistics and ANOVA of performance of students admitted during different academic years.

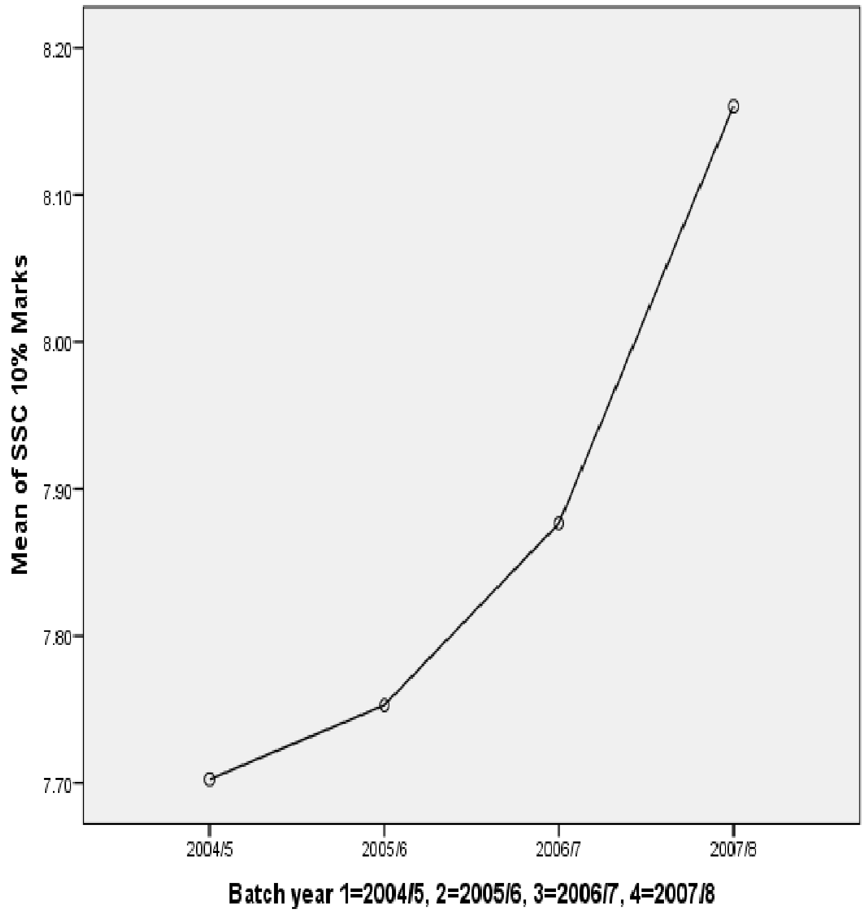
		N	Mean	SD	df	F	Sig
SSC 10% Marks	2004/5	368	7.70	0.78	3, 1579	32.69	.00
	2005/6	435	7.75	0.73			
	2006/7	418	7.88	0.72			
	2007/8	362	8.16	0.48			
	Total	1583	7.87	0.71			
HSC Three sub 40%	2004/5	0			1, 778	67.12	.00
	2005/6	0					
	2006/7	418	31.99	2.39			
	2007/8	362	33.28	1.93			
	Total	780	32.59	2.28			
HSC 40% of ALL subjects	2004/5	368	29.83	1.92	3, 1573	60.51	.00
	2005/6	435	30.05	1.76			
	2006/7	412	30.38	1.72			
	2007/8	362	31.40	1.43			
	Total	1577	30.39	1.81			
NTS50Percent	2004/5	368	36.92	8.63	3, 1579	323.84	.00
	2005/6	435	29.72	7.75			
	2006/7	418	21.50	6.34			
	2007/8	362	26.86	4.76			
	Total	1583	28.57	8.94			
Merit scores when 3 subjects are considered	2004/5	0			1, 940	189.55	.00
	2005/6	0					
	2006/7	494	61.22	7.59			
	2007/8	448	67.46	6.16			
	Total	942	64.19	7.61			
Merit Scores when all HSSC subjects are considered	2004/5	368	74.44	10.02	3, 1608	212.38	.00
	2005/6	462	67.22	9.03			
	2006/7	420	59.05	8.96			
	2007/8	362	66.42	5.27			
	Total	1612	66.56	10.11			
HSSC Language	2004/5	0			1, 775	22.65	.00
	2005/6	0					
	2006/7	414	353.95	33.02			
	2007/8	363	364.25	26.32			
	Total	777	358.76	30.50			

Basic Sciences Total	2004/5	413	58.27	10.90	3, 1965	67.62	.00
	2005/6	495	60.67	8.90			
	2006/7	585	61.61	8.96			
	2007/8	476	66.98	9.67			
	Total	1969	61.97	10.03			
Clinical Sciences Total	2004/5	407	65.48	5.70	3, 1956	42.74	.00
	2005/6	495	67.30	5.81			
	2006/7	587	68.19	6.12			
	2007/8	471	69.89	5.90			
	Total	1960	67.81	6.09			
MBBS	2004/5	396	62.24	6.00	3, 1910	88.00	.00
	2005/6	486	64.26	6.35			
	2006/7	571	65.27	6.49			
	2007/8	461	68.83	5.59			
	Total	1914	65.24	6.55			



	SSC 10% Marks	HSSC 40% of ALL subjects	HSSC Three sub 40 %	HSSC Language	FIRST Year MBBS Total	SECOND Year MBBS Total	THIRD Year MBBS Total	FOURTH Year MBBS Total	FIFTH Year MBBS Total	Basic Science Total	Clinical Science Total	MBBS Profession al Performan ce
batch 04/05	0.39	0.44			0.54	0.54	0.52	0.48	0.53	0.57	0.54	0.59
batch 05/06	0.36	0.35			0.50	0.54	0.47	0.55	0.48	0.52	0.54	0.58
batch 06/07	0.26	0.36	0.34	0.19	0.26	0.24	0.17	0.19	0.19	0.22	0.18	0.24
batch 07/08	0.04	0.15	0.12	0.14	0.34	0.28	0.21	0.26	0.25	0.28	0.28	0.31

Figure 4.9a The correlation of entrance test.



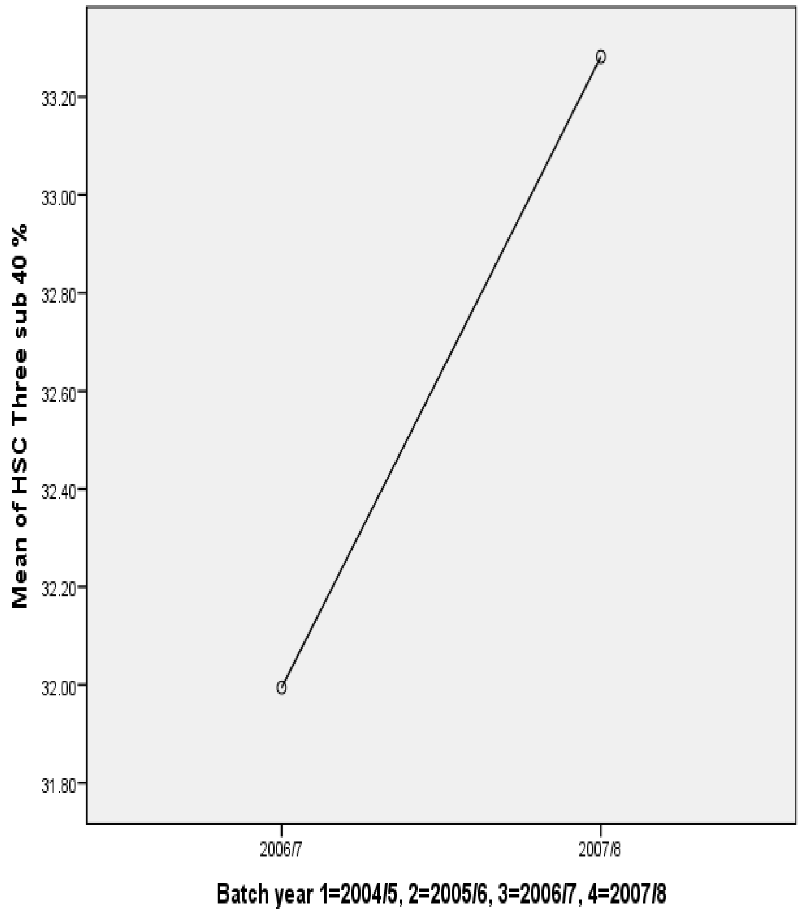
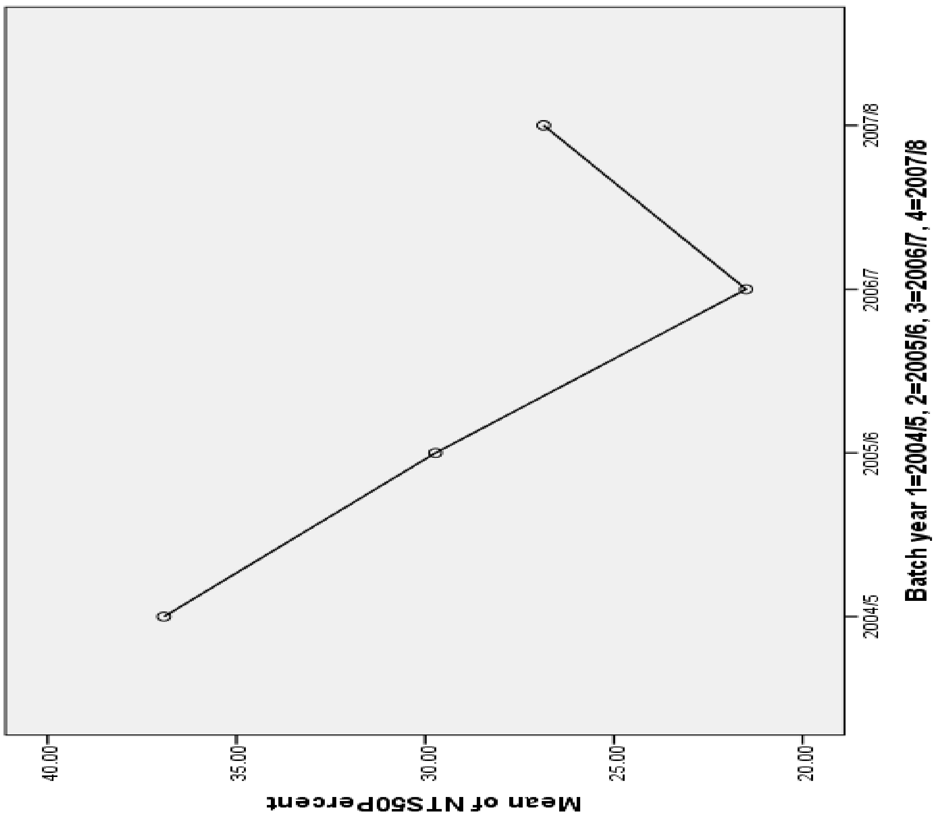
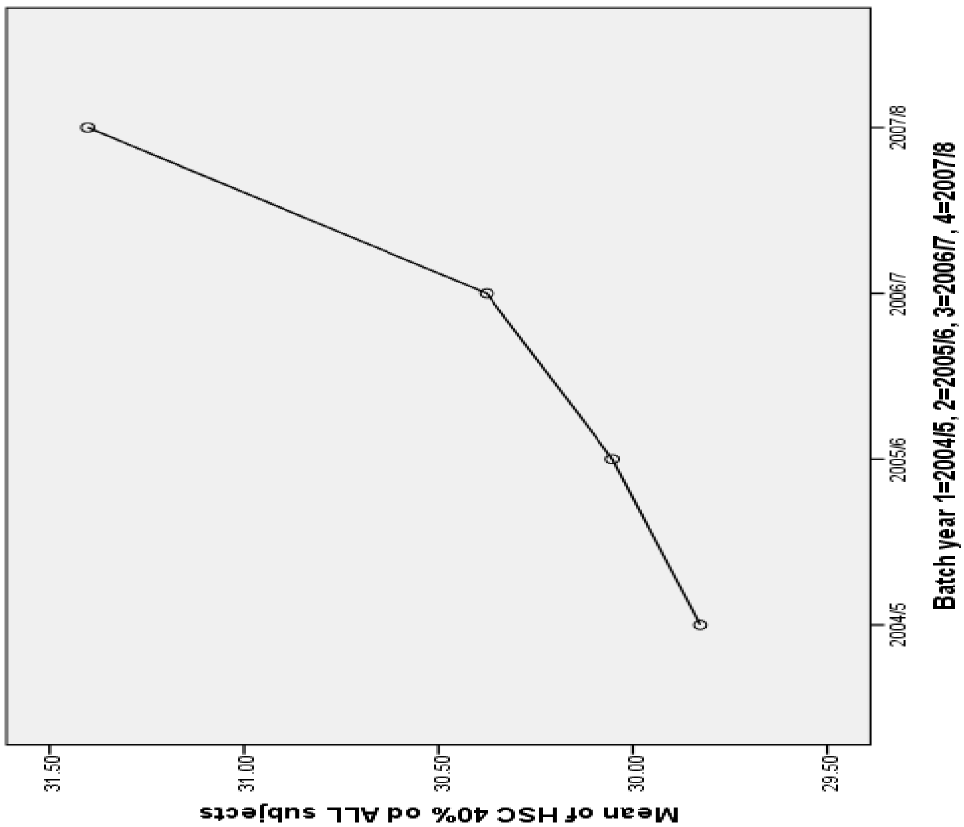
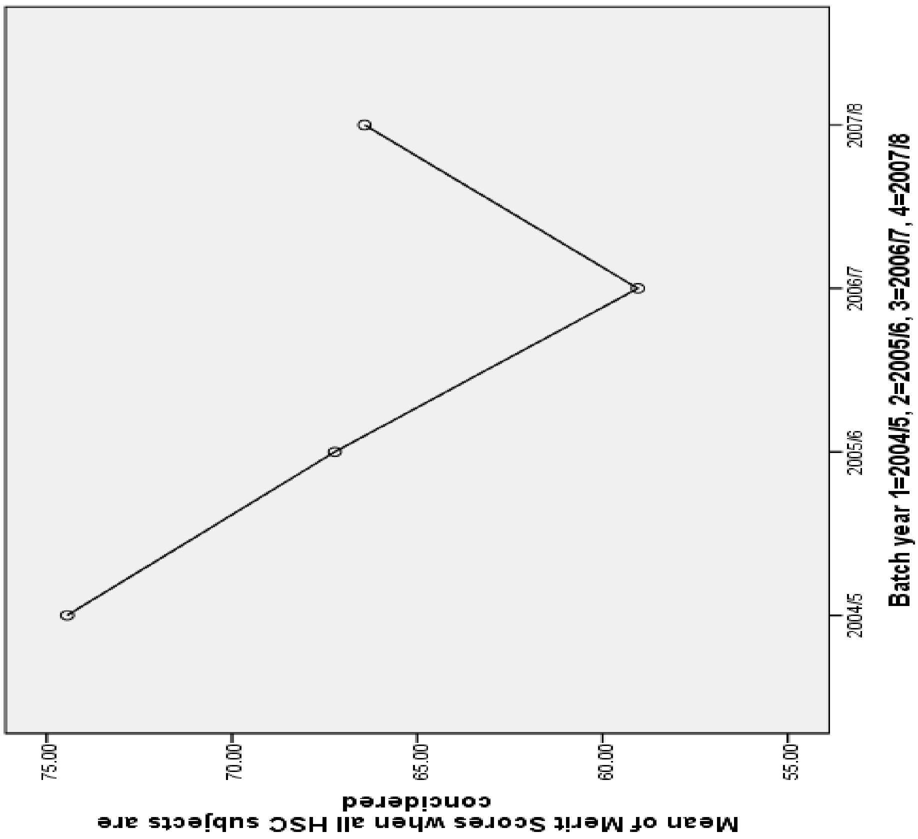


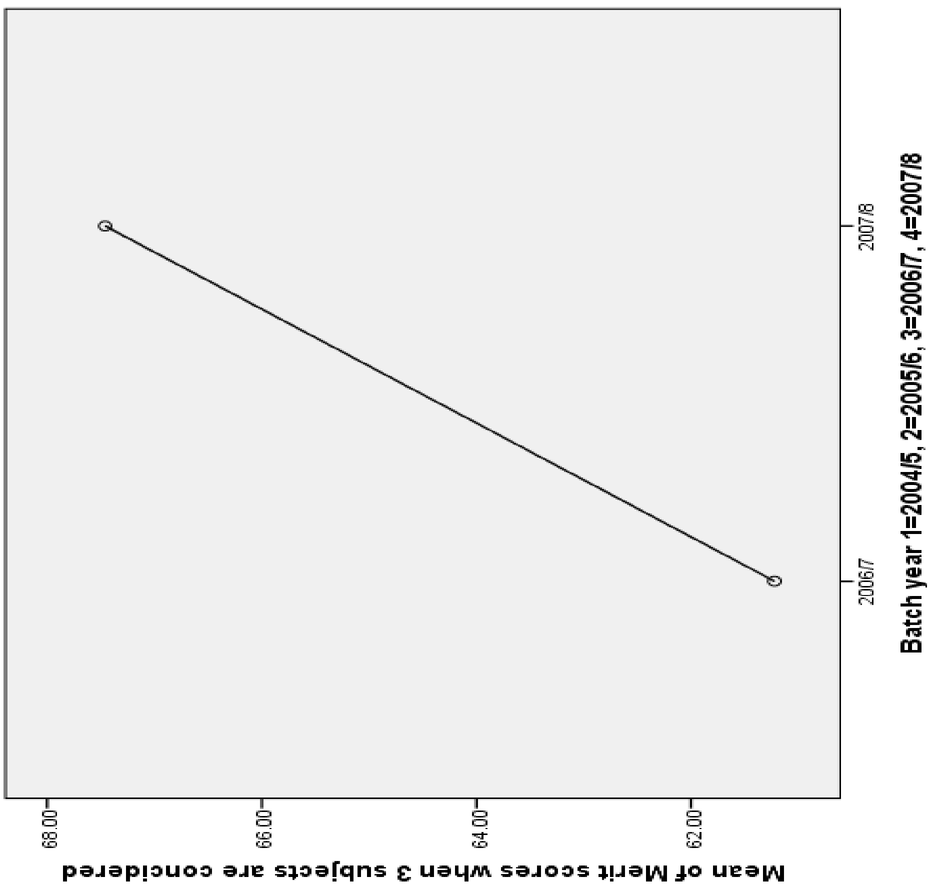
Figure: 4.10 The means plots of different school, NTS and undergraduate medical education assessment scores achieved during different years


Mean of NTS50Percent
40.00
35.00
30.00
25.00
20.00
2004/5
2005/6
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7, 4=2007/8

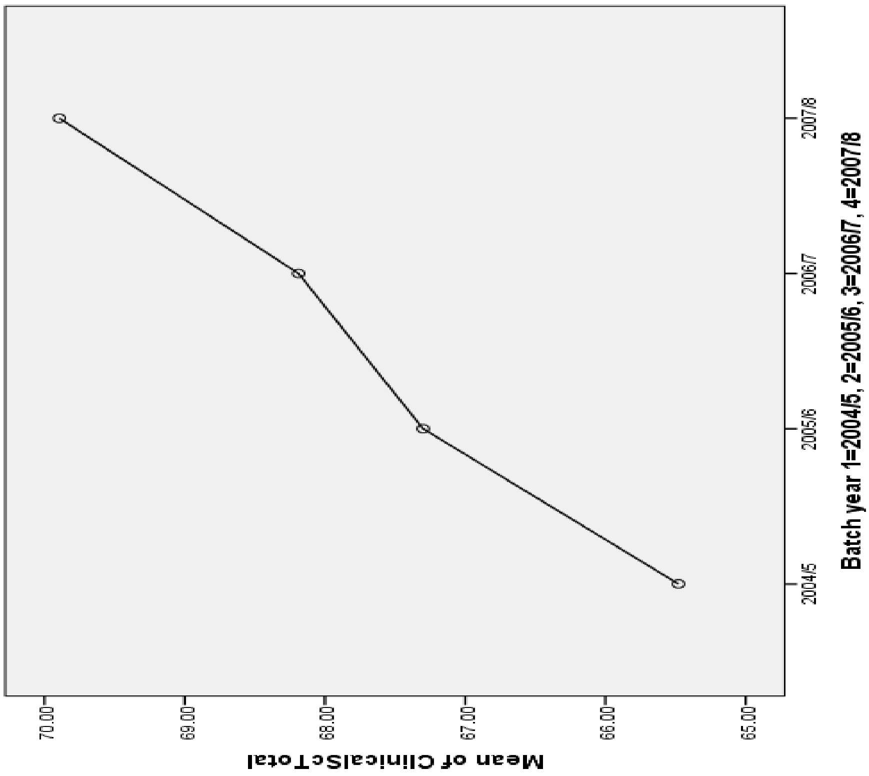

Mean of HSC 40% od ALL subjects
31.50
31.00
30.50
30.00
29.50
2004/5
2005/6
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7, 4=2007/8

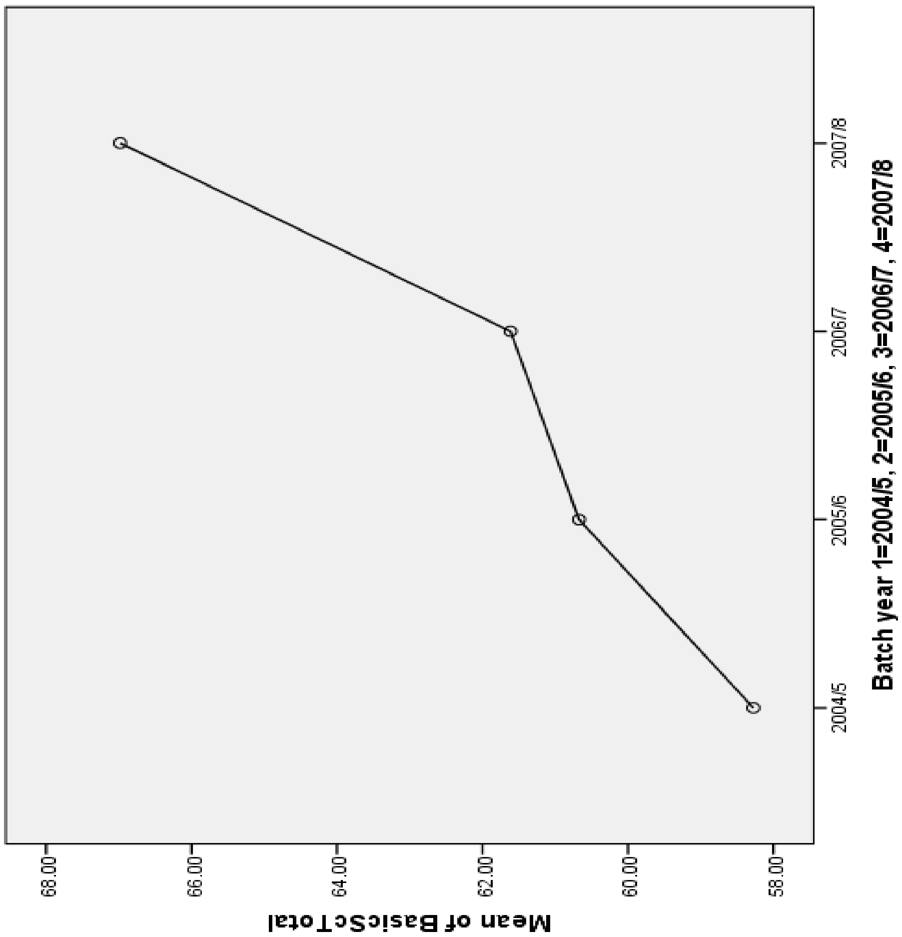


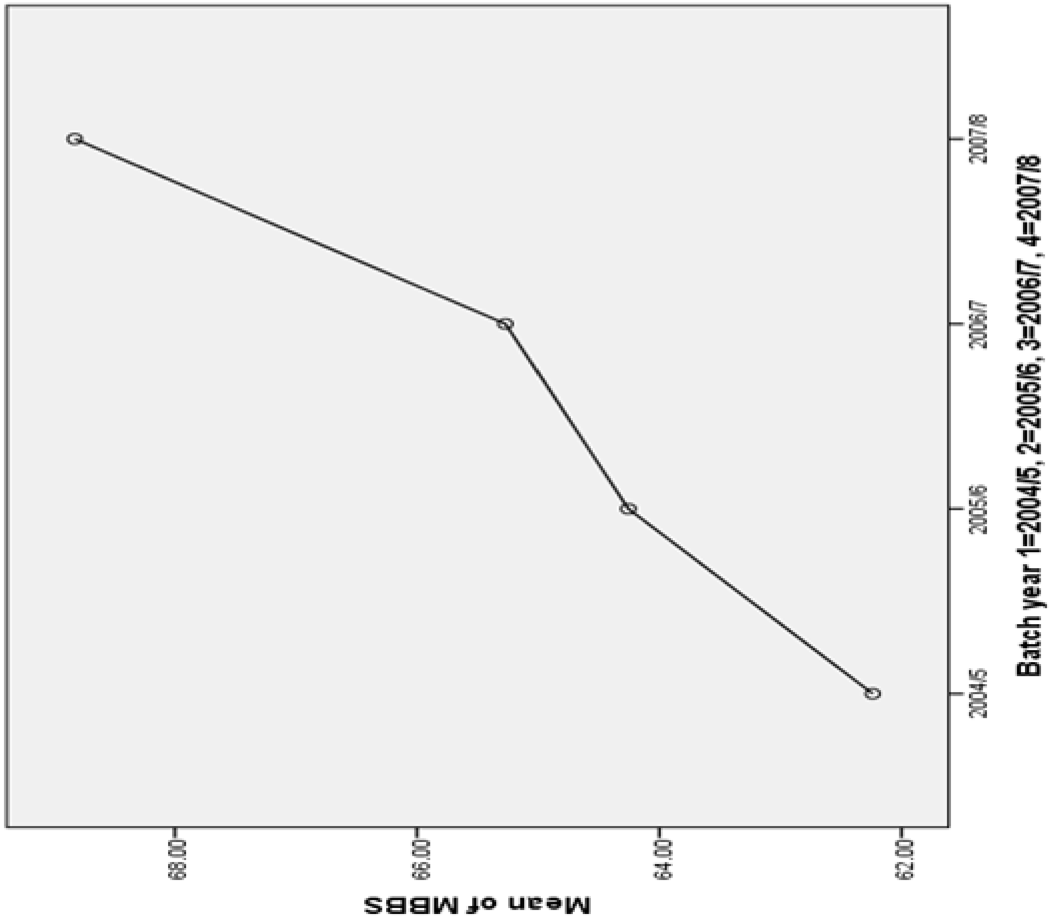
Mean of Merit Scores when all HSC subjects are concidered
75.00
70.00
65.00
60.00
55.00
2004/5
2005/6
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7, 4=2007/8



Mean of Merit scores when 3 subjects are concidered
68.00
66.00
64.00
62.00
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7, 4=2007/8


Mean of ClinicalScTotal
70.00
69.00
68.00
67.00
66.00
65.00
2004/5
2005/6
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7, 4=2007/8


Mean of BasicScTotal
68.00
66.00
64.00
62.00
60.00
58.00
2004/5
2005/6
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7, 4=2007/8


Mean of MBBS
68.00
66.00
64.00
62.00
2004/5
2005/6
2006/7
2007/8
Batch year 1=2004/5, 2=2005/6, 3=2006/7 , 4=2007/8

Further analysis of the medical education assessment scores achieved by students admitted during different calendar years shows that there is a significant difference in mean scores of students throughout five academic years. Table 4.15 show the ANOVA calculated on the mean score differences between various batches of students. The ANOVA across different batches of students over the course of medical education shows that the differences in achievements are statistically significant with $p < 0.001$ as shown in the table.

Table: 4.15 Academic achievements of different batches of students admitted during different years and difference of means between the batches.

Batch year		FIRST Year Total	SECOND Year Total	THIRD Year Total	FOURTH Year Total	FIFTH Year Total	Basic Sc Total	Clinical Sc Total	MBBS Total
2004/5	N	398	398	411	407	407	413	407	396
	Mean	61.42	61.76	57.28	62.53	66.87	58.27	65.48	62.24
	(SD)	6.52	7.64	8.98	6.51	5.78	10.90	5.70	6.00
2005/6	N	487	487	494	495	495	495	495	486
	Mean	62.32	63.95	59.10	69.12	66.51	60.67	67.30	64.26
	(SD)	7.60	8.07	8.08	7.07	5.81	8.90	5.81	6.35
2006/7	N	578	575	580	585	587	585	587	571
	Mean	62.87	64.77	60.63	71.31	66.64	61.61	68.19	65.27
	(SD)	6.92	8.90	7.63	6.86	6.01	8.96	6.12	6.49
2007/8	N	476	468	463	473	470	476	471	461
	Mean	64.63	69.21	70.45	71.30	67.53	66.98	69.89	68.83
	(SD)	7.89	6.43	7.55	7.11	6.84	9.67	5.90	5.59
Total	N	1939	1928	1948	1960	1959	1969	1960	1914
	Mean	62.86	65.02	61.87	68.93	66.87	61.97	67.81	65.24
	(SD)	7.35	8.30	9.42	7.69	6.13	10.03	6.09	6.55
Df		3,1935	3,1914	3,1944	3,1956	3,1955	3,1965	3,1956	3,1910
F		15.49	69.92	245.30	158.23	2.63	67.62	42.74	88.00
Sig		.00	.00	.00	.00	.00	.00	.00	.00

Table: 4.16a Pearson product correlation of various dependent and independent variables.

Pearson product coeeficient Correlations of various variables

		Closeness to Uni location	Gender CODED 1=Male, 2=Female	Urban Or Rural	SSC 10% Marks	HSC Three sub 40 %	HSC 40% od ALL subjects	Physics Total	ChemistryTotal	BiologyTotal	HSCLanguage	NTS50Percent	Merit scores when 3 subjects are concidered	Merit Scores when all HSC subjects are concidered	BasicScTheory	BasicScPractical	BasicScTotal	ClinicalScTheory	ClinicalScPractical	ClinicalScTotal	MBBSTheoryTotal	MBBSPracticalSkillsTotal	MBBS
Closeness to Uni location	Pearson Correlation	1	-.056*	-.309**	-.030	-.016	-.015	-.200**	.028	-.065	-.039	.024	.019	.033	-.015	-.017	-.016	.027	.009	.019	.050	.032	.004
	Sig. (2-tailed)		.014	.000	.242	.654	.558	.001	.639	.271	.280	.348	.563	.190	.520	.475	.496	.256	.705	.430	.192	.399	.878
	N	1905	1905	1905	1568	767	1562	289	289	289	763	1568	924	1597	1795	1795	1795	1781	1781	1781	680	680	1774
Gender CODED 1=Male, 2=Female	Pearson Correlation	-.056*	1	.089**	.172**	.051	.129**	-.012	.036	.087	.037	-.042	-.021	-.011	.091**	.224**	.164**	-.102**	.260**	.126**	.097*	.137**	.197**
	Sig. (2-tailed)	.014		.000	.000	.156	.000	.840	.547	.139	.302	.096	.521	.667	.000	.000	.000	.000	.000	.000	.011	.000	.000
	N	1905	2121	1915	1583	780	1577	289	289	289	777	1583	942	1612	1969	1969	1969	1960	1960	1960	697	697	1914
Urban Or Rural	Pearson Correlation	-.309**	.089**	1	.065*	.074*	.043	.047	-.046	.089	-.007	.130**	.052	.124**	.006	.034	.028	.060*	.020	.042	.149**	.159**	.027
	Sig. (2-tailed)	.000	.000		.010	.041	.089	.425	.437	.129	.841	.000	.115	.000	.812	.152	.237	.012	.393	.078	.000	.000	.257
	N	1905	1915	1915	1569	767	1563	289	289	289	763	1569	924	1598	1805	1805	1805	1791	1791	1791	681	681	1783
SSC 10% Marks	Pearson Correlation	-.030	.172**	.065*	1	.517**	.533**	.296**	.251**	.180**	.358**	.159**	.449**	.327**	.295**	.308**	.321**	.183**	.348**	.319**	.176**	.205**	.349**
	Sig. (2-tailed)	.242	.000	.010		.000	.000	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	1568	1583	1569	1583	780	1577	288	288	288	774	1582	775	1583	1484	1484	1484	1481	1481	1481	473	473	1474
HSC Three sub 40 %	Pearson Correlation	-.016	.051	.074*	.517**	1	.918**	.795**	.785**	.669**	.398**	.350**	.625**	.565**	.265**	.235**	.260**	.105**	.285**	.240**	.186**	.183**	.277**
	Sig. (2-tailed)	.654	.156	.041	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.005	.000	.000	.000	.000	.000
	N	767	780	767	780	780	774	288	288	288	774	779	775	780	728	728	728	727	727	727	406	406	720
HSC 40% od ALL subjects	Pearson Correlation	-.015	.129**	.043	.533**	.918**	1	.692**	.697**	.603**	.697**	.167**	.615**	.381**	.330**	.344**	.361**	.198**	.397**	.358**	.213**	.276**	.388**
	Sig. (2-tailed)	.558	.000	.089	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	1562	1577	1563	1577	774	1577	288	288	288	774	1576	769	1577	1478	1478	1478	1475	1475	1475	473	473	1468
Physics Total	Pearson Correlation	-.200**	-.012	.047	.296**	.795**	.692**	1	.652**	.645**	.585**	.050	.333**	.244**	.135*	.120*	.132*	.038	.107	.079	.113	.125*	.123*
	Sig. (2-tailed)	.001	.840	.425	.000	.000	.000		.000	.000	.000	.402	.000	.000	.026	.048	.029	.531	.078	.190	.064	.040	.043
	N	289	289	289	288	288	288	289	289	289	289	288	288	288	274	274	274	274	274	274	271	271	271
ChemistryTotal	Pearson Correlation	.028	.036	-.046	.251**	.785**	.697**	.652**	1	.626**	.574**	.129*	.395**	.313**	.111	.084	.102	.007	.052	.033	.079	.072	.078
	Sig. (2-tailed)	.639	.547	.437	.000	.000	.000	.000		.000	.000	.029	.000	.000	.066	.168	.093	.902	.394	.585	.198	.240	.203
	N	289	289	289	288	288	288	289	289	289	289	288	288	288	274	274	274	274	274	274	271	271	271
BiologyTotal	Pearson Correlation	-.065	.087	.089	.180**	.669**	.603**	.645**	.626**	1	.642**	.204**	.415**	.351**	.143*	.133*	.143*	.078	.158**	.128*	.138*	.162**	.155*
	Sig. (2-tailed)	.271	.139	.129	.002	.000	.000	.000	.000		.000	.000	.000	.000	.018	.028	.018	.195	.009	.034	.023	.007	.010
	N	289	289	289	288	288	288	289	289	289	289	288	288	288	274	274	274	274	274	274	271	271	271
HSCLanguage	Pearson Correlation	-.039	.037	-.007	.358**	.398**	.697**	.585**	.574**	.642**	1	.249**	.346**	.396**	.152**	.131**	.175**	.036	.121**	.098**	.094	.101*	.107**
	Sig. (2-tailed)	.280	.302	.841	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.335	.001	.009	.058	.041	.004
	N	763	777	763	774	774	774	289	289	289	777	773	769	774	725	725	725	724	724	724	407	407	716
NTS50Percent	Pearson Correlation	.024	-.042	.130**	.159**	.350**	.167**	.050	.129*	.204**	.249**	1	.946**	.951**	.188**	.136**	.186**	.269**	.072**	.174**	.290**	.073	.178**
	Sig. (2-tailed)	.348	.096	.000	.000	.000	.000	.402	.029	.000	.000		.000	.000	.000	.000	.000	.000	.005	.000	.000	.110	.000
	N	1568	1583	1569	1582	779	1576	288	288	288	773	1583	774	1583	1483	1483	1483	1480	1480	1480	473	473	1473
Merit scores when 3 subjects are concidered	Pearson Correlation	.019	-.021	.052	.449**	.625**	.615**	.333**	.395**	.415**	.346**	.946**	1	.953**	.438**	.393**	.434**	.171**	.363**	.322**	.420**	.358**	.422**
	Sig. (2-tailed)	.563	.521	.115	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	924	942	924	775	775	769	288	288	288	769	774	942	775	883	883	883	872	872	872	553	553	865
Merit Scores when all HSC subjects are concidered	Pearson Correlation	.033	-.011	.124**	.327**	.565**	.381**	.244**	.313**	.351**	.396**	.951**	.953**	1	.259**	.205**	.261**	.288**	.164**	.245**	.423**	.243**	.260**
	Sig. (2-tailed)	.190	.667	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	1597	1612	1598	1583	780	1577	288	288	288	774	1583	775	1612	1512	1512	1512	1509	1509	1509	498	498	1502
BasicScTheory	Pearson Correlation	-.015	.091**	.006	.295**	.265**	.330**	.135*	.111	.143*	.152**	.188**	.438**	.259**	1	.864**	.959**	.572**	.673**	.718**	.948**	.804**	.925**
	Sig. (2-tailed)	.520	.000	.812	.000	.000	.000	.026	.066	.018	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000	.000
	N	1795	1969	1805	1484	728	1478	274	274	274	725	1483	883	1512	1969	1969	1969	1947	1947	1947	697	697	1914
BasicScPractical	Pearson Correlation	-.017	.224**	.034	.308**	.235**	.344**	.120*	.084	.133*	.131**	.136**	.393**	.205**	.864**	1	.952**	.432**	.724**	.687**	.808**	.940**	.901**
	Sig. (2-tailed)	.475	.000	.152	.000	.000	.000	.048	.168	.028	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	1795	1969	1805	1484	728	1478	274	274	274	725	1483	883	1512	1969	1969	1969	1947	1947	1947	697	697	1914
BasicScTotal	Pearson Correlation	-.016	.164**	.028	.321**	.260**	.361**	.132*	.102	.143*	.175**	.186**	.434**	.261**	.959**	.952**	1	.495**	.699**	.700**	.915**	.909**	.970**
	Sig. (2-tailed)	.496	.000	.237	.000	.000	.000	.029	.093	.018	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	1795	1969	1805	1484	728	1478	274	274	274	725	1483	883	1512	1969	1969	1969	1947	1947	1947	697	697	1914
ClinicalScTheory	Pearson Correlation	.027	-.102**	.060*	.183**	.105**	.198**	.038	.007	.078	.036	.269**	.171**	.288**	.572**	.432**	.495**	1	.535**	.826**	.832**	.668**	.689**
	Sig. (2-tailed)	.256	.000	.012	.000	.005	.000	.531	.902	.195	.335	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000	.000
	N	1781	1960	1791	1481	727	1475	274	274	274	724	1480	872	1509	1947	1947	1947	1960	1960	1960	697	697	1914
ClinicalScPractical	Pearson Correlation	.009	.260**	.020	.348**	.285**	.397**	.107	.052	.158**	.121**	.072**	.363**	.164**	.673**	.724**	.699**	.535**	1	.918**	.673**	.864**	.871**
	Sig. (2-tailed)	.705	.000	.393	.000	.000	.000	.078	.394	.009	.001	.005	.000	.000	.000	.000	.000	.000		.000	.000	.000	.000
	N	1781	1960	1791	1481	727	1475	274	274	274	724	1480	872	1509	1947	1947	1947	1960	1960	1960	697	697	1914
ClinicalScTotal	Pearson Correlation	.019	.126**	.042	.319**	.240**	.358**	.079	.033	.128*	.098**	.174**	.322**	.245**	.718**	.687**	.700**	.826**	.918**	1	.810**	.842**	.907**
	Sig. (2-tailed)	.430	.000	.078	.000	.000	.000	.190	.585	.034	.009	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	1781	1960	1791	1481	727	1475	274	274	274	724	1480	872	1509	1947	1947	1947	1960	1960	1960	697	697	1914
MBBSTheoryTotal	Pearson Correlation	.050	.097*	.149**	.176**	.186**	.213**	.113	.079	.138*	.094	.290**	.420**	.423**	.948**	.808**	.915**	.832**	.673**	.810**	1	.833**	.955**
	Sig. (2-tailed)	.192	.011	.000	.000	.000	.000	.064	.198	.023	.058	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	680	697	681	473	406	473	271	271	271	407	473	553	498	697	697	697	697	697	697	697	697	697
MBBSPracticalSkillsTotal	Pearson Correlation	.032	.137**	.159**	.205**	.183**	.276**	.125*	.072	.162**	.101*	.073	.358**	.243**	.804**	.940**	.909**	.668**	.864**	.842**	.833**	1	.959**
	Sig. (2-tailed)	.399	.000	.000	.000	.000	.000	.040	.240	.007	.041	.110	.000	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	680	697	681	473	406	473	271	271	271	407	473	553	498	697	697	697	697	697	697	697	697	697
MBBS	Pearson Correlation	.004	.197**	.027	.349**	.277**	.388**	.123*	.078	.155*	.107**	.178**	.422**	.260**	.925**	.901**	.970**	.689**	.871**	.907**	.955**	.959**	1
	Sig. (2-tailed)	.878	.000	.257	.000	.000	.000	.043	.203	.010	.004	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	
	N	1774	1914	1783	1474	720	1468	271	271	271	716	1473	865	1502	1914	1914	1914	1914	1914	1914	697	697	1914

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table: 4.16b Pearson product correlation of various dependent and independent variables.

	NTS50Percent	Merit scores when 3 subjects are considered	Merit Scores when all HSC subjects are considered	Basic Sc Theory	Basic Sc Practical	Basic Sc Total	Clinical Sc Theory	Clinical Sc Practical	Clinical Sc Total	MBBS Theory Total	MBBS Practical Skills Total	MBBS
Gender	-.042	-.021	-.011	.091**	.224**	.164**	-.102**	.260**	.126**	.097*	.137**	.197**
Urban Or Rural	.130**	.052	.124**	.006	.034	.028	.060*	.020	.042	.149**	.159**	.027
SSC 10% Marks	.159**	.449**	.327**	.295**	.308**	.321**	.183**	.348**	.319**	.176**	.205**	.349**
HSSC Three sub 40 %	.350**	.625**	.565**	.265**	.235**	.260**	.105**	.285**	.240**	.186**	.183**	.277**
HSSC 40% of ALL subjects	.167**	.615**	.381**	.330**	.344**	.361**	.198**	.397**	.358**	.213**	.276**	.388**
HSSC Language	.249**	.346**	.396**	.152**	.131**	.175**	.036	.121**	.098**	.094	.101*	.107**
NTS50Percent		.946**	.951**	.188**	.136**	.186**	.269**	.072**	.174**	.290**	.073	.178**
Merit scores when 3 subjects are considered			.953**	.438**	.393**	.434**	.171**	.363**	.322**	.420**	.358**	.422**
Merit Scores when all HSC subjects are considered				.259**	.205**	.261**	.288**	.164**	.245**	.423**	.243**	.260**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The Tables 4.16a and b show the r values with significance level of correlation among different dependent and independent variables. When the university entrance test score variable was correlated with other variables, it was found that it has a weak insignificant negative correlation with gender (r = -0.042, $p > 0.05$), has a weak but significant positive correlation (r = 0.130, $p < 0.001$) with the urban residential location, a weak but positive correlation (r = 0.159, $p < 0.001$) with SSC grade X achievement, a moderate and positive correlation (r = 0.350, $p < 0.001$) with three science subject score has, a weak but positive relationship (r = 0.249, $p < 0.001$) with the language subject score and has a weak but positive correlation (0.167, *p* , 0.001) with HSSC cumulative score of all subjects (see Table 4.16).

The dependent variables basic science correlation results showed a weak to strong correlation with different variables. The female sex has weak positive relationship (r = 0.164, p < 0.001), SSC scores has a moderate (r =0.321, $p < 0.001$) relationship, HSSC three science subject score has a weak positive correlation (r = 0.260, $p < 0.001$), HSSC cumulative score of all subjects has a moderate (r = 0.361, $p < 0.001$) correlation, the language subject score has a weak but positive relationship (r = 0.175, $p < 0.001$) and the university entrance test score has a weak positive correlation (r = 0.186, $p < 0.001$). However the correlation of entrance with dependent variable shows a decline over the course of time, as shown in Fig 4.9a. While analysing the correlation of students' basic sciences achievement with the total admission score when only science subjects scores were considered and when scores of all subjects were calculated, it was observed that the admission scores with three sciences subjects only has a strong correlation (r = 0.434, $p < 0.001$) as opposed to the admission score when all HSSC subjects (science and language) were considered the r value dropped (r = 0.261, $p < 0.001$).

The dependent variables clinical science correlation results showed a weak to strong correlation with different variables. The female sex has weak positive relationship (r = 0.126, p < 0.001), SSC scores has a moderate (r =0.319, p < 0.001) relationship, HSSC three science subject score has a weak positive correlation (r = 0.240, p < 0.001), HSSC cumulative score of all subjects has a moderate (r = 0.358, p < 0.001) correlation, the language subject score has a weak but positive relationship (r = 0.098, p < 0.01) and the university entrance test score has a weak positive correlation (r = 0.174, p <0.001). While analysing the correlation of students' clinical sciences achievement with the total admission score when only science subjects scores were considered and when scores of all subjects were calculated, it was observed that the admission scores with three sciences subjects only has a moderate positive correlation ($r = 0.322$, $p < 0.001$) as oppose to the admission score when all HSSC subjects (science and language) were considered the r value dropped ($r = 0.245$, $p < 0.001$).

The dependent variable MBBS correlation results showed weak to strong correlation with different independent variables. The female sex has weak positive relationship ($r = 0.197$, $p < 0.001$), SSC scores has a moderate ($r =0.349$, $p < 0.001$) relationship, HSSC three science subject score has a weak positive correlation ($r = 0.277$, $p < 0.001$), HSSC cumulative score of all subjects has a moderate ($r = 0.388$, $p < 0.001$) correlation, the language subject score has a weak but positive relationship ($r = 0.107$, $p < 0.01$) and the university entrance test score has a weak positive correlation ($r = 0.178$, $p <0.001$). While analysing the correlation of students' MBBS total professional achievement with the total admission score when only science subjects scores were considered and when scores of all subjects were calculated, it was observed that the admission scores with three sciences subjects only has a strong positive correlation ($r = 0.422$, $p < 0.001$) as opposed to the admission score when all HSSC subjects (science and language) were considered the r value dropped ($r = 0.260$, $p < 0.001$).

Multiple Regression analysis

The different scores including achievement scores in NTS, SSC, HSSC science (Biology, Physics and chemistry) subjects, HSSC language subjects, and demographics of gender and residential address of either living in rural or urban area were regressed on NTS achievement, basic sciences, clinical sciences and MBBS final outcome scores to examine the predictive power of different elements in various proposed models. The regression coefficients, p values and adjusted R^2 values of statistically significant models predicting the different outcome variables are shown in Table 4.17. The comprehensive regression analysis for all predictive and outcome variables are shown in Table 4.18.

Multiple regression analysis was conducted to investigate how well predictor variables SSC 10 %, HSSC 40% of science subjects, HSSC 40% of all subjects, total science subjects scores, total language subject scores, individual score in biology, physics and chemistry, permanent residential location and gender predict the achievement in university entrance test. Stepwise method of regression analysis method showed the HSSC science subjects, language subjects' scores, SCC scores and male sex significantly predict the achievement scores in NTS test. The regression was a moderate fit ($R^2_{adjusted} =14.9\%$), however the model was significant, ($F_{4,755} = 34.13$, $p <0.001$). To analyse the relationships of predictive variables and outcome variable of Basic science, the same stepwise regression analysis was performed.

Table 4.17: Effective regression models predicting outcome variables from dependent predictor variables.

Dependent variable	Predictors variables	b	SE b	β	R2 adjusted	F	df	p sig
University Entrance Test/NTS					14.9 %	34.13	4,755	<0.00
	HSSC Three sub 40 %	.728	.112	.258				.00
	HSSC Language	.034	.011	.116				.00
	SSC 10% Marks	1.118	.392	.113				.00
	Gender	-.884	.427	-.070				.03
Basic Sciences					21.5%	39.74	5,704	<0.00
	NTS50Percent	.427	.045	.342				.00
	University Location	4.071	.647	.216				.00
	HSSC Three sub 40 %	.319	.136	.093				.01
	Urban Or Rural	1.715	.659	.089				.00
	SSC 10% Marks	.999	.472	.081				.03
Clinical sciences					11.5%	31.78	3,705	<0.00
	NTS50Percent	.252	.037	.257				.00
	HSSC Three sub 40 %	.358	.102	.133				.00
	Gender	1.316	.425	.110				.00
MBBS					20.7 %	46.77	4,697	<0.00
	NTS50Percent	.344	.037	.337				.00
	University Location	3.212	.537	.207				.00
	HSC Three sub 40 %	.407	.101	.145				.00
	Urban Or Rural	1.805	.547	.114				.00

The university entrance test score, university location, HSSC science subjects' scores, urban residential location and SSC scores predicted significantly the achievement scores in basic sciences. The regression was stronger with R2 adj = 21.5% and model was also significant (F 5,704 = 39.74, p <0.01). The same predictors were used to assess their predictive power for achievement in clinical sciences. The scores in NTS, HSSC science subjects' scores and female sex best predicted the clinical sciences achievement. The model regression fit was moderate (R2 adj =11.5%) and significant (F 3,704 =31.78, p <0.01). The final outcome variable of MBBS was also measured against same predictor variables which formed the parts of university admission process. Similar to basic and clinical sciences achievement the scores in university entrance test and HSSC science subjects' scores, along with being urban student at NMC predicted the best the outcome variable of MBBS. The model was strong with (R2 adj = 20.7%) and significant (F 4,697 = 46.77, p <0.01).

Tables 4.19 to 4.22 summarize the descriptive and inferential statistical tests for main outcome variable of the study. The outcome variables include university entrance test, basic science achievement score, clinical sciences achievement score and MBBS final professional performance.

Table 4.18: Stepwise regression analysis of university entrance test, basic sciences, clinical sciences and MBBS by predictor variables.

Outcome Variable	Model	Predictor variables	*b*	SE *b*	β	*P*	$R^2_{adjusted}$
NTS	1	HSC Three sub 40 %	1.00	0.10	0.36	0.00	0.13
	2	HSC Three sub 40 %	.857	.103	.304	.000	0.14
		HSSC Language	0.86	0.10	0.30	0.00	
	3	HSC Three sub 40 %	0.04	0.01	0.13	0.00	0.15
		HSSC Language	0.74	0.11	0.26	0.00	
		SSC 10% Marks	0.03	0.01	0.11	0.00	
	4	HSC Three sub 40 %	1.01	0.39	0.10	0.01	0.15
		HSSC Language	0.73	0.11	0.26	0.00	
		SSC 10% Marks	0.03	0.01	0.12	0.00	
		1=Male, 2=Female	1.12	0.39	0.11	0.00	
Basic Sciences	1	NTS50Percent	-0.88	0.43	-0.07	0.04	0.15
	2	NTS50Percent	0.49	0.04	0.39	0.00	0.19
		University Location	0.50	0.04	0.40	0.00	
	3	NTS50Percent	3.75	0.64	0.20	0.00	0.20
		University Location	0.44	0.05	0.35	0.00	
		HSC Three sub 40 %	3.77	0.63	0.20	0.00	
	4	NTS50Percent	0.46	0.12	0.14	0.00	0.21
		University Location	0.44	0.05	0.35	0.00	
		HSC Three sub 40 %	4.16	0.65	0.22	0.00	
		Urban Or Rural	0.44	0.12	0.13	0.00	
	5	NTS50Percent	1.72	0.66	0.09	0.01	0.22
		University Location	0.43	0.05	0.34	0.00	
		HSC Three sub 40 %	4.07	0.65	0.22	0.00	
		Urban Or Rural	0.32	0.14	0.09	0.02	
		SSC 10% Marks	1.72	0.66	0.09	0.01	
Clinical Sciences	1	NTS50Percent	1.00	0.47	0.08	0.04	0.09
	2	NTS50Percent	0.30	0.04	0.30	0.00	0.11
		HSC Three sub 40 %	0.25	0.04	0.25	0.00	
	3	NTS50Percent	0.38	0.10	0.14	0.00	0.12
		HSC Three sub 40 %	0.25	0.04	0.26	0.00	
		1=Male, 2=Female	0.36	0.10	0.13	0.00	

MBBS	1	NTS50Percent	1.32	0.43	0.11	0.00	0.15
	2	NTS50Percent	0.39	0.04	0.38	0.00	0.18
		University Location	2.782	.532	.179	0.00	
	3	NTS50Percent	0.40	0.04	0.39	0.00	0.20
		University Location	2.799	.525	.181	0.00	
		HSC Three sub 40 %	2.78	0.53	0.18	0.00	
	4	NTS50Percent	.344	.037	.337	.00	0.21
		University Location	0.34	0.04	0.34	0.00	
		HSC Three sub 40 %	2.80	0.53	0.18	0.00	
		Urban Or Rural	0.43	0.10	0.15	0.00	

Table: 4.19 The *t* statistics, ANOVA and stepwise regression analysis of university entrance test by predictor variables.

Statistical Tests	Variable	N	Mean	Std. Deviation		t or F value	Df	*p* sig
t statistics	Male	671	29.07	9.17		1.68	1567	.09
	Female	898	28.30	8.74				
	LMC	1359	28.90	9.39		5.60	521.46	.00
	NMC	224	26.53	5.05				
	Close to uni	869	28.44	8.97		-.93	1566	.34
	Away from uni	699	28.86	8.89				
	Rural/Non-Cosmopolitan	1188	27.97	8.43		-4.73	560.79	.00
	Urban/Cosmopolitan	381	30.68	10.08				
	Merit	1129	31.79	6.94		25.42	685.50	.00
	Self Finance	433	20.53	8.15				
ANOVA		N	Mean	Std. Deviation		F	Df	sig
	2004/5	368	36.92	8.63		323.84	3, 1579	.00
	2005/6	435	29.72	7.75				
	2006/7	418	21.50	6.34				
	2007/8	362	26.86	4.76				
	Total	1583	28.57	8.94				
Regression Analysis		*b*	SE *b*	β	R^2 adjusted	F	df	*p* sig
					14.9	34.13	4,755	<0.00
	HSC Three sub 40 %	.728	.112	.258				.00
	HSSC Language	.034	.011	.116				.00
	SSC 10% Marks	1.118	.392	.113				.00
	1=Male, 2=Female	-.884	.427	-.070				.03

Table: 4.20 The *t* Statistics, ANOVA and stepwise regression analyses of basic sciences by predictor variables.

Statistical Tests	Variable	N	Mean	Std. Deviation		t or F value	df	*p* sig
t statistics	Male	795	59.98	9.57		-7.35	1967	.00
	Female	1174	63.32	10.10				
	LMC	1577	61.08	9.58		-8.95	1967	.00
	NMC	392	65.55	10.95				
	Close to uni	903	63.14	8.01		.68	1793	.49
	Away from uni	892	62.87	8.88				
	Rural/Non-Cosmopolitan	1357	62.85	8.66		-1.18	1803	.23
	Urban/Cosmopolitan	448	63.40	7.74				
	Merit	1261	65.13	7.03		15.55	698.58	.00
	Self Finance	487	57.73	9.55				
ANOVA	2004/5	413	58.27	10.90		67.62	3, 1965	.00
	2005/6	495	60.67	8.90				
	2006/7	585	61.61	8.96				
	2007/8	476	66.98	9.67				
	Total	1969	61.97	10.03				
Regression Analysis		b	SE b	β	R2 adjusted	F	df	*p* sig
					21.5%	39.74	5,704	<0.001
	NTS50Percent	.427	.045	.342				.00
	University Location	4.071	.647	.216				.00
	HSC Three sub 40 %	.319	.136	.093				.01
	Urban Or Rural	1.715	.659	.089				.00
	SSC 10% Marks	.999	.472	.081				.03

Table: 4.21The *t* Statistics, ANOVA and stepwise regression analysis of clinical sciences by predictor variables.

Clinical Sciences								
Statistical Tests	Variable	N	Mean	Std. Deviation		T or F value	df	*p* sig
t statistics	Male	793	66.88	5.66		-5.71	1812.74	.00
	Female	1167	68.44	6.29				
	LMC	1581	67.35	6.27		-8.15	723.17	.00
	NMC	379	69.74	4.79				
	Close to uni	899	68.01	6.03		-.78	1779	.43
	Away from uni	882	68.24	5.88				
	Rural/Non-Cosmopolitan	1343	67.98	5.82		-1.76	1789	.07
	Urban/Cosmopolitan	448	68.55	6.31				
	Merit	1258	69.47	5.28		14.64	743.11	.00
	Self Finance	476	64.73	6.27				
ANOVA	2004/5	407	65.48	5.70		42.74	3, 1956	.00
	2005/6	495	67.30	5.81				
	2006/7	587	68.19	6.12				
	2007/8	471	69.89	5.90				
	Total	1960	67.81	6.09				
Regression Analysis		b	SE b	β	R2 adjusted	F	df	sig
					11.5%	31.78	3,705	<0.001
	NTS50Percent	.252	.037	.257				.00
	HSSC Three sub 40 %	.358	.102	.133				.00
	Gender	1.316	.425	.110				.00

Table: 4.22 The *t* Statistics, ANOVA and stepwise regression analysis of MBBS by predictor variables.

Statistical Tests	Variable	N	Mean	Std. Deviation		t	df	Sig. (2-tailed)
T Statistics	Male	772	63.68	6.27		-8.76	1912	.00
	Female	1142	66.30	6.53				
	LMC	1537	64.51	6.69		-12.22	755.516	.00
	NMC	377	68.24	4.93				
	Close to uni	894	65.51	6.51		-.153	1772	.87
	Away from uni	880	65.56	6.41				
	Rural/Non-Cosmopolitan	1337	65.43	6.28		-1.13	1781	0.25
	Urban/Cosmopolitan	446	65.83	6.94				
	Merit	1252	67.19	5.71		17.21	774.49	.00
	Self -Finance	475	61.40	6.43				
ANOVA	2004/5	396	62.24	6.00		88.00	3, 1910	.00
	2005/6	486	64.26	6.35				
	2006/7	571	65.27	6.49				
	2007/8	461	68.83	5.59				
	Total	1914	65.24	6.55				
Regression Analysis		b	SE b	β	R2 adjusted	F	df	sig
					20.7 %	46.77	4,697	<0.00
	NTS50Percent	.344	.037	.337				.00
	University Location	3.212	.537	.207				.00
	HSSC Three sub 40 %	.407	.101	.145				.00
	Urban Or Rural	1.805	.547	.114				.00

To summarise the main findings of the study suggest that majority of students in this study attended a university located near an urban city. The average age of student is 18.17 years. The student intake from rural areas corresponds to the population distribution of the country. The performance of students coming from urban areas is only better than rural origin students in pre-university assessments including entrance test. The majority of students in this study are female and their performance is better than male students. The entrance test scores have a weak positive correlation with the outcome variables. The school achievement, specially

HSSC science subject scores, has a strong positive correlation with the outcome variables. A model of HSSC science subjects' scores, scores in HSSC language, SSC scores and male sex predicted the achievement in entrance test. In this study a model of entrance test scores, admission in a university located close to an urban city, achievement in three science subjects and being resident of an urban area forms theoretically the most coherent model for predictive validity of future performance.

CHAPTER FIVE

DISCUSSION

This chapter presents the interpretation of results of the study and analyses the differences and similarities of the results with other similar studies. The discussion will start with the main findings, demographical differences and differences in performances. It will then present predictive validity coefficients and regression analyses of various independent and dependent variables. The chapter will end with recommendations, conclusion and limitation of the study.

The main findings of the study are:

1. Majority of students in this study attend university located near an urban city.
2. The average age of student is 18.17 years.
3. The student intake from rural areas corresponds to the population distribution of the country.
4. The performance of students coming from urban areas is only better than rural origin students in pre-university assessments including entrance test.
5. The majority of students in this study are female and their performance is better than male students.
6. The entrance test scores have a weak positive correlation with the outcome variables.
7. The school achievement, especially HSSC science subject scores, has a strong positive correlation with the outcome variables.
8. A model of HSSC science subjects' scores, scores in HSSC language, SSC scores and male sex predicted the achievement in entrance test.
9. In this study a model of entrance test scores, admission in a university located close to an urban city, achievement in three science subjects and being resident of an urban area forms theoretically the most coherent model for predictive validity of future performance.

Although the record of age of candidates was not available directly, the age of candidates was calculated indirectly. Based on the year of passing SSC grade X, HSSC grade

XII and enrolment in medical school, the average age of the student calculated was 18.17 years. Schripsema et al. (2014) reported almost the same mean age 18.9 years of students. This average age at the time of enrolment, represents the phenomenon of young age school leavers entrance in the medical universities of Pakistan. As in this study the range of age was narrow between 18 and 19 years only as shown in Table 4.1 (p 62). There is no graduate entry admission scheme in medical schools of Pakistan which might have given us a difference in the age and in addition the effect of age on learning in a medical school context showed conflicting results (Herman & Veloski, 1981; Salem et al., 2013). Because of the narrow range of ages the relationship of age on achievement was not analysed further.

The numbers of enrolments showed an increasing trend until 2006/7 intake as seen in Table 4.5 (p 66). The numbers of students admitted on merit criteria still show an increasing trend over four years of study. The decrease seen in Fig4.8 (p 67) is related to a decrease in students admitted on self-financing scheme. This decrease could be attributed to the opening of new private medical colleges which attracted full fee paying students. As Abubakar et al. (2010) highlighted, the private medical schools in Pakistan use various methods more effectively to market their facilities and quality of services provided and hence attract more students. Furthermore this drop in the number of self-finance students is observed in LMC, an institution which is located close to a metropolitan city. This could once again be attributed to opening of new competitive private medical colleges. As financial sustainability in higher education is becoming a challenge (Briggs & Wilson, 2007; Gill & Gill, 2000; Salmi, 1992) loss of funding due to decrease in full fee paying students might further reduce the resources and quality. The reduction of quality would further impact the image of institution and the choice and selection of institution by candidates (Bringula & Basa, 2011). Table 4.6 (pg 69) further shows that full fee paying female candidates having a rural residential address admitted on self-financing scheme preferred to join LMC. This institutional choice demonstrates a preference of full fee paying students to join an institution which is located in an urban area rather joining an institution in rural area.

The gender composition of the study suggests that there are more female students than male students pursuing medicine as profession as seen in Table 4.2 (p 63). This difference is likely to be due to one of the two medical schools selected for the study is for female students only. The other medical school being coeducational, there were more male students than female. Observation of gender distribution in four batches of students in LMC did not show any particular trend in the selection based on gender. The lower success rate of female candidates in selection process is reported by Mitterauer et al. (2008). As opposed to previous practice of admission based on gender (Margulies, 1963), the current open merit system of selection did favor female candidates as seen from number of enrolled female students.

The issue of poor health care facilities in rural areas is a chronic one (McGirr & Whitfield, 1965). The selection of health professionals from rural areas is seen as one of the solutions of the problem (Dolea et al., 2009; Snadden, 2011; Yang & Richardson, 2013). Keeping the definition of rural setting as suggested by Couper (2003) in mind, the urban-rural composition of the enrolled students studied points out a clear majority of 75.2% of students have a rural residential background. This composition reflects the rural settlement of the majority of population of Pakistan (Pakistan Bureau of Statistics, 2016). Whether the students with a rural background, after completion their studies have made any impact on the rural health care delivery in Pakistan or not remains elusive. The poor physician to population ratio of 0.473 per 1000 (Talati & Pappas, 2006) is far from ideal (Khan, 2004). A total of 151,852 registered general practitioners (Pakistan Medical and Dental Council, 2016) for a population of approximately 200 million is far too small.

Gender

The current study shows that the performance of female students is better than male students in SSC grade X assessment and HSSC grade XII assessment scores including all science and language subjects only. In SSC grade X assessment females scored (M = 7.97, SD = 0.68) higher than males (M = 7.72, SD = 0.73) with t (1567) = -6.99, p <.001). In HSSC grade XII assessments including all science and language subjects, females scored (M = 30.60, SD = 1.76) higher than males (M = 30.12, SD = 1.85) with t = (1396.01) = -5.21, p <.001. McManus et al. (2003) and McManuset al. (2013) reported the similar underperformance of male students (estimate = -.0699, SE 0.0309) in prior school attainment. In pre-entry variables Hewage et al. (2011) reported English language subject scores of female candidates (M= 62.9, SD = 12.2) compared to male (M = 53.6, SD = 15.3) were better with a t-statistic=5.333, $p < 0.001$.

The performance of female students during medical education has been statistically significantly higher than male with a p value between 0.000 – 0.03 as shown in Table 4.9 (p 78) and 4.9a (p 79). The performance of female students, in NMC exclusive for female students, was better than in coeducational LMC. As the cultural context of the current study has similarities to the one mentioned by Salem et al. (2013), a separate female campus could be associated with better performance of female students. Regardless of the difference in demographic variables including residential settlement, distance from university and admission criteria performance of female students remain higher as shown in Table 4.9c (p 79). The superior performance of female students during medical education could be related to other motivational factors.

University

It is evident from the analysis shown in table 4.10 (pg 81 – 82) that the NMC admitted a smaller number of students compared to LMC; however the overall performance of students at NMC has been significantly higher than those of university B. This study supports that the female students in a female only university are performing better during medical education. Kargic and Poturak (2014) emphasized the selection of a university in student's life is important. Young people aspiring for future look for institutions which provide them distinctive educational knowledge and experience. Table 4.10a (p 83) suggests that high achieving full fee-paying students choose NMC. These students show their motivation and commitment with the studies by performing significantly better than the students who only performed better in pre-university school assessments. The performance of students admitted in NMC was significantly better than students of LMC. According to Bringula and Basa (2011) a university located in the rural area faces more challenges of attracting students. In this study it is noted that over the academic years recorded in this study, the number of full fee-paying students did not decrease in a NMC located in rural area as seen in Fig 4.8c (p 68). Briggs and Wilson (2007) suggested, students are becoming more considerate in making appropriate decision while choosing a university.

Admission schemes

In the view of financial issues the public universities try to generate funds by admitting students under self-financing scheme. These students pay full fees as opposed to students admitted on merit. The students admitted under merit scheme criteria achieved statistically significant higher scores in SSC and HSSC examination, entrance test and assessments during medical education. The scores generated from the same test could be used differently to broaden the student admission (Dowell et al., 2011; Fernando et al., 2009). This study confirms the research findings of Schripsema et al. (2014) suggesting that the students admitted on the basis of higher pre university GPA perform better than any other criteria.

Students having different residential background and coming to university from different distances

The demographic analysis of this study shows that 75.2 % of students have a rural background. As mentioned before, admitting strategically a larger number of students having a rural back ground could solve the issue of shortage of doctors serving in the rural areas of Pakistan. This admission strategy reflects the WHO recommendation suggesting to recruit candidates with rural background (Dolea et al., 2009; Yi et al., 2015). Students with a rural background are more likely to serve in their communities (Snadden, 2011; Yang & Richardson, 2013). It is not known whether students graduating from the two institutes selected in this study serve in their communities or not. Hence the impact of admission strategy in addressing the shortage of rural doctors is not known. Though the majority of students admitted have a rural background, the pre-university performance of rural students is significantly lower than students having urban background as seen in Table 4.12 (pp 86 – 87). However, during medical education at university the difference in achievement of two student groups was not statistically significant. The difference in pre-university performance indicates the lack of educational facilities in rural areas of Pakistan. In Pakistan the poor quality of public school system especially in rural areas is due to a lack of political will, low investment in education and environmental challenges (Jerrard, 2016) . This abysmal situation of public school system resulted in the rapid increase in the private school system (Andrabi et al, 2008). Behrman et al. (1997) showed a clear link between the poor school quality and cognitive achievement. Furthermore, the students in urban areas might have easy access to better quality private schools and coaching institutes which help students with preparation for their SSC, HSSC examinations and entrance tests. Alcott and Rose (2015) highlighted the learning crisis in the rural setting of Pakistan. The effect of schooling and coaching on inflating the performance is reported by Jones and Vanyur (1986), Zeleznik et al. (1987) and Alcott and Rose (2015). Once the students are exposed to the similar educational standards the difference in performance disappears. This phenomenon of initial difference in performance which later disappears is also reported by Thiele et al. (2016). It would be interesting to know if the enrolled students attended a private school or public school and whether they attended a coaching institute or not in order to clearly understand the effect of these factors on performance in the context of Pakistan.

There are different factors influencing students' decisions in choosing university include site where the university is located (Clarke, 2007). While parents choosing educational institutions for their children also consider home-school distance (Burgess et al., 2015). Students have to travel different distances to attend the university. It is assumed that students coming from long distances relocate themselves close to university or live in hostels. As compared to day scholars who can commute daily to university, hostellers come from long distances and prefer to stay in hostels often felt stressed due to difficulty in adjustment with new college environment and colleagues, and in returning home (Qamar et al., 2015; S. Shaikh et al., 2010). However Shaikh et al. (2004) reported almost similar prevalence of stress in day scholars and hostellers in medical schools. The studies by Qamar et al. (2015), Shaikh et al. (2010) and Shaikh et al. (2004) were conducted in Pakistan and measured only the stress level among students. Sohail (2013) reported from the same context that stress is related closely to performance. This study reports on performance of students who live in home town located close to university or live away from university and relocate themselves. The academic performance of two groups is not statistically significantly different as shown in Table 4.11 (pp 84 – 85).

Entrance test

The medical college admission test started early in 1928 in the USA. A similar test was started almost after half a century in 1981 in a private medical school of Pakistan. Now it is one of the mandatory requirements in all private and public medical schools of Pakistan. It is administered by the NTS for different provinces. The achievement in the entrance test weighs 50% in calculation for the final admission scores. Unlike other medical college admission tests conducted in various other countries, the educational value of entrance test in public medical schools of Pakistan is not researched in depth.

Since the inception of MCAT in the US, it has been revised five times to incorporate or modify different section of the test in order to emphasize the link between social and professional values and aptitude for medical education (Callahan et al., 2010a; McGaghei, 2002). However the entrance test used in Pakistan has not been revised. The most significant and recent change observed in the admission process is consideration of achievement in the three science subjects only instead of all science and language subjects assessed in HSSC examination. This perhaps undermines the importance of language subjects like English,Urdu and Sindhi. In the entrance test with 100 questions, 90 test questions are allocated for science disciplines and only 10 items are test English language skills.

In the entrance test achievement the difference between male and female students (Table 4.8, p 77) is not statistically significantly different. Koeniget al. (1998) also reported a lack of difference between sexes in MCAT achievement. The students admitted in LMC located closer to an urban area performed statistically significantly higher than students admitted in NMC. This shows the phenomenon of attracting high achieving students to an institution located in urban areas. This could be due to either institution located closer to an urban area (Bringula, 2012; Bringula & Basa, 2011) or better institutional marketing and image as highlighted by Abubakar et al. (2010) and Briggs and Wilson (2007). If the education standards measured as the performance of students, the high achieving students should have opted for NMC. The students of NMC consistently performed better than the students of LMC. This paradox shows a similarity with the selection of institution is based on socioeconomic class rather than classroom mentioned by Elacqua et al. (2006).

Understandably, the students who were admitted on merit criteria have a higher achievement scores in entrance test than students admitted on self-finance admission scheme. The scores achieved by students in entrance test showed a decrease across time as shown in Table 4.14 (pp 90-91). This decrease is also seen in the correlation of entrance test scores in predicting the future performance (Fig 4.9a, p 92). Callahan et al. (2010a) also reported that there was no significant improvement in the validity coefficient of MCAT. The decline in the entrance test scores and predictive coefficient measured as Pearson correlation requires psychometric and content analysis of the entrance tests in order to evaluate the reliability and validity of entrance tests. The decreasing trend in scores could possibly be due to a mismatch between the course content of HSSC and entrance tests. Though positive, a decreasing predictive coefficient suggests that the entrance test is not effectively assessing what is required of students during medical education.

Correlations

The correlation provides the linkage between the previous and current achievements (McManuset al., 2013) , hence the correlations shows the predictive power of a test. As Donnon et al. (2007) reported small to medium predictive validity coefficient for MCAT, this study found a small positive but significant correlation of entrance test with pre-clinical and clinical year achievements. Similarly UMAT also has a small correlation with performance in initial year of university studies (Wilkinson et al., 2011).

The correlation between school achievement and academic performance during medical education showed a small significant correlation (McManus et al., 2003). This study also demonstrates that there is medium but significant correlation between SCC achievement and basic and clinical sciences scores (Table 4.16b). Furthermore, HSSC scores calculated by addition of all science and language scores were better predictors of performance both in preclinical and clinical years. Also the correlation is better for clinical years than pre-clinical years. As shown in Table 4.16a (p 99) this study supports a similar conclusion (McManus et al., 2003) that the later performance in medical schools is not only related to initial performance during medical education but also to the performance at school as well. This study adds that the inclusion of achievement in the language subjects improves the correlation further.

Although the difference of achievement in HSSC between rural and urban student is not statistically significant, the difference in entrance test achievement is statistically significant with urban students performing better than rural students. Could this difference in entrance test achievement be attributed to difference in standards of school education or commercial coaching available in urban areas as reported by Jones and Vanyur (1986) and Zeleznik et al. (1987)? In this study the difference in school standard could only be attributed to the difference in SSC achievement not the HSSC. The students from urban areas performed better in SSC examination only. The availability of commercial coaching in urban areas could be a possible factor which enhanced the performance of students from urban settlements.

Regression model

The HSSC science subjects, language subjects' scores, SCC scores and male sex significantly predict the achievement scores in entrance test. The final outcome variable of MBBS was also measured against same predictor variables which formed the parts of university admission process. The outcome variable MBBS is best predicted by achievements in university entrance test, HSSC science subjects, basic and clinical sciences, along with being an urban student admitted in NMC. McManus et al. (2003) and McManus et al. (2013) also reported similar statistically significant results showing the previous school performance predicted future performance in basic and clinical sciences assessment during medical education. This study also supports Shulruf et al. (2012a) suggesting school achievement as a strong positive predictor of performance in medical school achievement. The three science subjects, namely physics, chemistry and biology assessed in HSSC examination, formed three subsets of entrance test as well. Although in this study different subset scores of entrance test was not available, the performance in those three science subjects if assumed same as performance in HSSC then this study supports Brooks et al. (1981) and Essex et al (1980) suggesting the higher predictive power of science subjects for future performance. Similarly, if the scores achieved in language subjects assessed in HSSC equated with language subset of entrance test, this study reports that achievement in language subjects did not add in prediction of future performance. This is similar to finding by (Gilbert et al., 2002).

As mentioned earlier, the compulsory use of entrance tests is a relatively new phenomenon in Pakistan, it is imperative to evaluate the logical, psychometric and empirical evidence to justify their prominent role in decision making during selection processes in medical schools. The entrance tests are theorized as an important screening process for selection of appropriate candidates. The predictive power of any process should show logical, psychometric and empirical consistency. The logical fitness of process needs to be verified empirically by measuring its predictive power (van de Vliert, 1981). The measure of predictive power of any entrance test has been considered as the most important empirical evidence to justify the significance of the test in decision making. The main research question raised in this study regarding the education value is: to what extent the entrance test and other component parts considered for admission in medical university or school predict the future cognitive performance of candidates.

This study reports that entrance test predicts positively the academic performance in basic sciences and clinical sciences. It predicts positively the overall professional performance at the exit level. The entrance test has correlation value r = 0.18, $p < 0.01$ with basic sciences. The entrance test correlates with clinical sciences with r = 0.17, $p < 0.01$; while with the overall MBBS performance, entrance test correlates with r = 0.18, $p < 0.01$. In contrast to entrance test, a cumulative score of all HSSC subjects shows a stronger correlation with outcome variables. HSSC score has r value of 0.36, 0.36 and 0.38 with basic sciences, clinical sciences and MBBS overall performance respectively with $p < 0.01$. SSC grade X score also shows a stronger correlation with r value 0.32, 0.32 and 0.35 with basic sciences, clinical sciences and MBBS overall performance respectively with $p < 0.00$. The scores in university entrance test and HSSC science subjects' scores also predicted the best outcome variable of MBBS. The model was strong with (R^2_{adj} = 20.7%) and significant ($F_{4,697}$ =

46.77, p <0.01).

In summary the best predictor of scores in the medical course is the HSSC score followed by the SSC and the entrance test. This does raise questions about the use of the entrance test in making selection decisions for entry into medicine. During decision making for selection of students, higher weighting is allocated to entrance test i.e. 50%. While in the process of selection HSSC and SSC are allocated a weighting of 40% and 10% respectively. The results of this suggest that more weighting should be allocated to HSSC and SSC achievement. In Pakistan, currently not giving due weighting to school achievements has unduly undermined the significance of school achievements. This disproportionate distribution of weighting has moved the focus of students to achieve higher grades in entrance test than in school assessments. This shift in the focus has led the growth of coaching centers offering entrance test preparation classes and charging hefty fees.

Limitations

In regards to statistical strength and generality of findings, the issue of restriction of range is the most important challenge faced in this and similar other studies (Lang et al., 2010; Ones & Viswesvaran, 2003; Raju & Brand, 2003; Raju et al., 2006; Sackett et al., 2007; Sackett & Yang, 2000; Schmidtet al., 2006; Stauffer & Mendoza, 2001). The issue of restriction could not be addressed as the mean and standard deviation of different variables of the unrestricted sample was not available. In regards to the source of data, only the admission and assessment records were shared by the universities. The actual assessment tools, results or admissions forms were not shared due to either lack of availability or confidentiality. As there was not access to assessment tools including examination papers and methods of compiling the results it was not possible to appreciate the similarity or differences in standards of educational assessments across two universities and during different years. As opposed to many other similar studies which used some sort of standardised examination like national licensing, residency or fellowship examinations as outcome variables, this study used MBBS performance as a standard. As there was no access to the actual admission forms submitted by the applicants, some of the demographic data of interest could not be collected for the study. The address variable used in this study may not be a true reflection of where actually the candidates were residing at the time of admission. This is because candidates might have moved into urban areas and received education there but acquired admission based of original hometown address.

Strengths

This study fills the knowledge niche of research related to selection in public medical schools of Pakistan. This study used a large number of students in two medical universities with varied student intake. This study spans over four cohorts of students. This study not only highlighted the educational significance of entrance test but also linked the effects of advantaged and disadvantaged students on performance. This study is statistically sound as it used appropriate statistical methods and tests to analyse the data and make appropriate inferences.

Future directions

In regards to having an entrance test as one of the requirements, it needs to be aligned more with what is required of health professional during and after they complete their studies. In the current situation HSSC science subject achievement alone could predict future cognitive performance especially in initial years more than the entrance test scores. Hence, the selection process including the calculation for the final selection scores should be re-evaluated and more weightage should be given to HSSC science scores than entrance test scores. The selection of students based on regional quota should continue, otherwise more students will come from advantaged urban areas and disadvantaged rural areas will be under represented.

In regards to study design and data collection, the data should be collected from several different public and private institutions located in various provinces of Pakistan. To further strengthen this and similar other studies conducted in Pakistan, access to admission data and assessment tools used in different universities should be made easily accessible to investigators by legislation.

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Attachment:

Attachment:

NTS Building Standards in Educational and Professional Testing

9. Objective and clear thinking make the study of science
A. Easier
B. Difficult
C. Fruitful
D. Enjoyable
E. Boring

10. Experiments and research work are
A. Different
B. Related
C. Unrelated
D. Opposite
E. parallel

CHEMISTRY

11. The rate of a chemical reaction is:

A. determined from a balanced chemical equation
B. the change in concentration of products and reactants in a certain amount of time
C. not possible to determine experimentally
D. expressed in units of time
E. None of the above

12. In neutralization:

A. the base is neutralized
B. the acid is neutralized
C. a salt is formed
D. water is formed
E. all of the above

13. An alkene with 16 carbons has a molecular formula of:

A. C_{16} H_{16}
B. C_{16} H_{34}
C. C_{16} H_{8}
D. C_{16} H_{32}
E. C_{16} H_{48}

14. In 80 grams of NaOH, there are:

A. 2 moles of NaOH
B. 1 mole of NaOH
C. 3 moles of NaOH
D. 0.5 moles of NaOH
E. 5 moles of NaOH

15. α-rays (Alpha) are:
A. fast moving electrons
B. protons
C. neutron
D. positively charged helium nuclei
E. negatively charged helium nuclei

16. Iso-pentane and neo-pentane are the examples of:

A. Functional group isomerism
B. Position isomerism
C. Chain isomerism
D. Metamerism
E. None of the above

BIOLOGY

23. End of menstrual cycle in old age is called:

A. Andropause
B. Menopause
C. Gametopause
D. Sterility
E. Hemophilia

24. Genotype ratio of Mendel's Law of independent assortment is:

A. 3 : 1
B. 1 : 2 : 1
C. 9 : 3 : 3 : 1
D. 3:3
E. 3:2

25. Which of the following is a characteristic of land plants?

A. Multicellular plant body
B. Heterogamy
C. Alternation of generations
D. Cell wall
E. All of the above

26. Molds and yeasts are classified as

A. Rhodophytes
B. Bryophytes
C. Fungi
D. Ciliates
E. Flagellates

27. Which compound captures light energy in plants?

A. O_2
B. CO_2
C. H_2O
D. Chlorophyll
E. None of the above

28. Which is correctly associated?

A. RNA: thymine
B. DNA: uracil
C. RNA: replication
D. RNA: picks up amino acids
E. RNA: ribose sugars