**Similar achievements between graduates of the regular medical track and those admitted via the pre-medical track**

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**Running head:** Similar achievements between students in direct medical and pre-medical tracks

Key words: (up to 5)

**Abstract**

**Objectives**

To evaluate the association between the achievements of medical students and whether they were admitted via the pre-medical (PREMED) track or the regular direct track, using data from a three-year experimental PREMED cohort in a six-year medical school.

**Methods**

This is a retrospective coded data study, analyzing information from three cohorts of students. All students admitted to the medical school in 2013-2015, either directly to the program (MED) or via the PREMED track, were included in the study. We compared the academic achievements of the students in the MED program with those admitted via the PREMED track.

**Results**

Of the 324 students included in the study, 65 (20.1%) were enrolled in the PREMED track. Gender distribution was similar in the two groups. In the third cohort (admitted in 2015), MED students were slightly older (30.9 y) than PREMED students (30.1 y) (p=0.049). For the first and second cohorts, the final grades of year one of PREMED students were significantly higher than those of MED students, but the opposite was true for the third cohort. No other statistically significant differences were found between the groups in the final grades of the following years. We found no significant association between choosing the MD/PhD option and admission pathway because of the small number of MD/PhD students.

**Conclusions**

Our results, which are consistent with previous international findings, should encourage further discussion about the significant potential human resources lost by current admission processes, and question the effectiveness of six-year programs in medical schools.

**Introduction**

Every year, medical schools throughout the world are tasked with selecting a handful of candidates out of many eligible applicants. The decisions made in the selection process have implications for public health.1 Thus, apart from cognitive ability, selection criteria include character attributes, such as altruism, empathy, reliability, communication skills, and others. 2 Validating the effectiveness of the selection process is highly complex and requires a lengthy follow-up during the integration of graduates into the medical workforce and their subsequent years in practice.3 Attempts to validate the admission process are presented in a large body of literature that focuses on students’ achievements in admission tests, through their years of study, and in their final examinations. The studies provide substantial evidence for a direct correlation between admission scores and academic achievements in the following years. 3-7 In contrast, evidence for the reliability of interviews and other humanistic models is limited, 13 and the ability of these models to examine personal qualities or predict academic achievements and clinical performance is not well established. 8

A pre-medical program, common in the United States and Canada, is an educational academic track that qualifies students and facilitates their subsequent selection into medical school. The pre-medical track offers courses on core subjects that prepare students for medical studies. These include courses for allied health professions, community involvement, clinical experience, and research experience. Some pre-medical programs provide broad-based preparation for professional tracks, and can prepare students for entry into a variety of primary professional programs or graduate degrees with similar prerequisites (including schools of medicine, veterinary medicine, and pharmacy.) Most studies show a positive correlation between student achievement in pre-medical programs and their achievements through their years in medical school. 9

Academic pre-medical programs are not offered by all universities and colleges across the world. Many medical schools consider high school studies as ‘pre-medicine’. A student in an academic pre-medical track can choose an undergraduate program in any field, as long as prerequisite courses for the medical program are included. The courses primarily focus on the scientific fields of biology, chemistry, organic chemistry, brain sciences, behavioral sciences, and physics, which provide the necessary preparation for the MCAT entrance exam and meet the admission requirements of medical schools. 12 For this reason, students in the pre-medical track, tend to choose a major related to one of these scientific fields. However, in recent years, a growing number of students with a background in the humanities are applying for medical school, a trend that is well-received by the schools. For example, the Mount Sinai School of Medicine established a specific program for non-scientific majors. The Humanities and Medicine Program (HuMed) caters to graduates in humanities and social sciences and does not require the MCAT or scientific courses. 10

At Ben Gurion University, medical studies have been taught for 49 years as a six-year program. Admission to the medical school is based on final school grades, an interview and a computerized personality test, or alternatively, on two interviews. The number of applicants increases every year, and it is five times higher than the admission quotas. The same is true of the other three established medical schools in Israel. In 2013, for the first time at our school, we trialed the “Graduate in Medical Sciences” study program as a three-year program that provided a pre-medicine track. The program was intended for candidates who achieved high scores in the admission process, including the interviews, but were not among those admitted to the medical school because of the limited number of places.

The program was designed to provide an alternative track, where students study basic sciences at an undergraduate level and acquire basic clinical knowledge in a program that is nearly identical to that of the six-year medical track. An additional focus of the program was a specifically designed biomedical research course. Graduates could continue directly to the fourth year of medical studies, either in the regular MD track or in the MD/PhD clinician-researcher track. Other options for graduates included medical studies in a four-year program at a different academic institution or studying towards a Master’s degree at Ben Gurion University or any other academic institution.

The program was first offered at our university in 2013. The initial suggestion was that only the top 60% of graduates who successfully completed the ‘Graduate in Medical Sciences’ program could continue their medical studies at the Joyce and Irving Goldman School of Medicine at the Ben-Gurion University of the Negev. However, in practice, based on considerations of the health system in Israel, admission quotas have increased annually. Therefore, the PREMED program was gradually shortened, and the students joined the six-year medical program. The first cohort students attended the PREMED program for two years before they joined the third year of the six-year medical program, the second cohort joined the medical program after one year, and the third cohort joined the direct medical program right from the beginning.

The Ministry of Health and the Council for Higher Education intend to continue to increase the annual intake of Israeli medical students from 750 to 1000 in the coming years for two main reasons. The first is a shortage of physicians per capita, which could be addressed by promoting relatively fast training tracks for physicians in Israel and abroad. The second is the need to train physicians with a good level of education adapted to the Israeli health system.

In practice, there has been a significant increase in the number of Israeli students studying medicine abroad. Currently, approximately six out of ten new doctors in Israel have been trained and qualified abroad - a proportion that is, unfortunately, the highest in the OECD countries. The implications of medical training abroad are twofold: the theoretical and professional training is sometimes provided by institutions known to have a substandard level of teaching, and there is no real opportunity for educational influence on the character of a medical doctor who returns to the country already qualified.

Forums on medical education often debate whether the time has come to change the model of medical studies.14-15 On the one hand, the six-year programs offer the deans an extended period and more diverse means to shape and influence the students. On the other hand, four-year programs have the advantage of accepting mature students from diverse academic backgrounds, including physics, nursing, East Asian studies, philosophy, and chemistry. Mature students admitted to the medical schools can choose various tracks from the start, such as conjoint research, entrepreneurship, or management tracks, according to their areas of interest and backgrounds.

At a time when the number of doctors and the quality of medicine appear to be out of balance, we wish to explore, through the opportunity provided by the three cohorts of the PREMED program, the potential achievements of students who were not initially admitted to medical school, some of whom would likely choose to study abroad. Alternatives to the traditional six-year program could provide worthy academic options that would allow for an increase in the number of locally trained students.

The objective of our study was to evaluate the association between the achievements of medical students and whether they were admitted via the PREMED track or the regular direct track.

**Methods**

***Study design***

A retrospective coded data study design was used to analyze anonymized records from the examination department at the school of medicine. The records were divided into two groups: those of students admitted via the PREMED track and those of students in the direct medical track. Data were collected for all students who enrolled in the three years the PREMED program was offered, in 2013-2015. The data included: gender, year of birth, yearly grade means, weighted decile values, and final examination grades.

Inclusion criteria were all students admitted to the medical school between 2013 and 2016, either in the direct track or the PREMED track. Exclusion criteria were students admitted during these years who discontinued their studies in the clinical years and did not take the final examinations (a total of four students, all in the direct track.)

We compared the academic achievements between students in the direct MED track and those admitted via the PREMED track, for all students who enrolled in the three years the PREMED program was offered, between 2013 and 2015. We compared the yearly final grades and the final medical examinations grades between the two groups.

***Number of participants***

Grades were compared for a total of 324 students, divided into two groups. Out of all the students, 65 (20.1%) were in the PREMED track. Stratified by year, the PREMED students comprised 12.4% of all students admitted in 2013 (11/87), 16.8% (18/107) of students in the 2014 class, and 28.1% (36/128) in the 2015 class. Data for the two cohorts of 2013 and 2014 were combined in the analysis because their study structure was similar to each other and different from that of students in the direct track. Students in the third cohort of 2015 joined the direct medical track in the first year, and their data were analyzed separately.

***Statistical analysis***

Statistical analysis was carried out in three stages. The first stage entailed descriptive statistics. Means and standard deviations are presented for continuous variables and distribution and percentages for categorical variables. The second stage was univariate analysis. Outcome variables were compared between the groups and between other predictive variables, such as age and gender. We compared the gender and age of the students between the two groups. We used a T-test to compare students’ ages and a χ2 test to compare gender between the two groups. We compared students’ yearly final grades and their grades in the final medical examinations. A T-test was used to compare the mean grades between the two groups. In the third stage, a multivariate analysis was carried out by linear regression and quantile regression (for quantiles: 0.1; 0.25; 0.50; 0.75; 0.90; 0.95). The two methods were used to evaluate the interaction between study track and age, and interaction between study track and gender. p<0.05 was considered statistically significant. Statistical analysis was performed using SPSS (version 26) (IBM SPSS STATISTICS).

**Results**

***Similar demographics of the study cohorts***

To evaluate the association between the academic achievements of students admitted to the direct MED track compared to students admitted to the PREMED track, we compared the grades of 324 students divided into two groups. In the first and second cohorts, a total of 29 (17%) and 144 (83%) students were admitted into the PREMED and direct MED programs, respectively. The third cohort comprised 36 (28%) and 92 (72%) students in the PREMED and the direct MED programs, respectively.

There was no significant difference in gender distribution between the two groups in any of the three cohorts. Comparison of students’ age found that in the third cohort, students in the direct MED track were slightly older (30.9 years) than students in the PREMED track (30.1 years) (p=0.049). The results are presented in Table 1.

***Final grades were similar between students in the MED track and students admitted via the PREMED track***

Our comparison of the final grades between the MED and PREMED groups in the three cohorts focused on the final grades of year one, the means of the first three years, the means of years four to six, the cumulative means of the six years, and the final examination grades in the different disciplines.

Interestingly, in the first and second cohorts, the final grades of year one of the PREMED students were significantly higher than those of the MED students. This outcome may be related to the requirements for transitioning into the medical program and the specific study structure of these two cohorts. In the third cohort, we also found a significant difference in the final grades of year one between the two groups, but here the MED students had the higher grades.

No significant differences were found between the groups, for any of the three cohorts, in grades achieved in the following years, except for the final examination in psychiatry in the third cohort, with the mean grade of the MED group higher (81.2±4.5) than that of the PREMED group (79.7±2.7) with p=0.025. The results are presented in Table 2.

***Final grades were similar between students in the MED track and students admitted via the PREMED track after adjusting for age and gender, using multivariate and quantile regression analyses***

In a multivariate analysis, we tested the association between the study track and the final grades after adjusting for the demographic variables of gender and age, and found no significant interactions with the dependent variables. Data were analyzed by linear regression and quantile regression, which was used to determine the effect on the dependent variable at different grade quantiles in addition to the effect on the mean grade.

The variable ‘study track’ was significantly associated with year one grades of students in the first and second cohorts when analyzed by linear regression and quantile regression for quantiles 25, 50, and 70. After adjusting for age and gender, students in the PREMED track had higher grades than students in the MED track. In all other years of study and the final examinations, the variable ‘study track’ did not affect the grades. In the third cohort, no significant effect was found for any of the study years. However, in the final examinations of the third cohort, the variable ‘study track’ had a significant effect on the grades in the high quantiles: 75, 90, and 95. After adjusting for gender and age, students in the PREMED track had lower grades than students in the MED track. The results are presented in Table 3.

***Similar number of students from MED and PREMED track chose the MD/PhD option***

We found no significant difference or a trend between students in the PREMED or MED track in joining the MD/PhD program, because of the small number of students in this program. The results are presented in Table 4.

**Discussion**

PREMED programs throughout the world aim to assist in selecting medical students who meet specific cognitive and personality criteria. The selection criteria are based on qualities that would be essential for the students in their future work as physicians. The variability between programs in different schools stems from the particular nature of the local or international medical school, the local or international health needs, and the admission quotas that are appropriate for each medical school throughout the world.

Admission scores have been shown to correlate directly with the level of academic success, and academic achievements in PREMED have been shown to correlate with those in PRECLINIC.6, 7, 16 The ability of the different programs to influence the ethical aspects of a student’s personality is still controversial, and studies determining the effects of the PREMED program on these aspects remain inconclusive.9 In addition, it is known that students’ ambition and motivation change during their years of study and throughout their clinical and academic careers.17

The difference in motivation is reflected in the achievements of the three PREMED cohorts. Overall, there was no difference in the academic achievements between students in the PREMED track and those in the direct track. However, the grades of the two first cohorts of the PREMED students, whose transition to the medical program was based on academic achievements, were significantly higher than the grades of students in the third cohort and of students in the direct track. Several factors were likely to contribute to the psychological element and the increased motivation of PREMED students in the first two cohorts. These include the fact that the separate PREMED admission track offered a unique opportunity for students who would not have been accepted to the medical school in previous years, and the fact that only a proportion of the PREMED students were able to join the medical program. The finding of the higher achievements of PREMED students is consistent with the literature but was unique here, given the exceptional conditions of our program. It is evident that students in the third cohort, who were directly integrated into the medical program, were less ambitious than students in the two previous cohorts.

Further evidence for the effect of motivation on academic achievements was provided by the results of the two first PREMED cohorts in the later years of study. Once the students were notified that they had been accepted into the medical program, their mean grades decreased and were no longer different from those of the other students. It appears that the acceptance to the medical program reduced the pressure and somewhat reduced grades. However, according to the quantile analysis, students who were highly motivated from the beginning maintained their level of motivation. This is demonstrated by the observation that students with high grades had even higher grades than those in the direct MED track in later years. Students of the first PREMED cohort maintained top grades throughout their years in academia – could that be a result of a selection bias? Could we conclude that the students had a higher level of commitment? Our study also found that PREMED students in all cohorts were more motivated to join the MD/PhD research track, but this was not significant because of the small number of participants.

The PREMED opportunity that was provided to only three cohorts raises a disturbing, practical concern about all those students rejected from medical studies because of the limited number of available places. The achievements of the three student cohorts over the years of study and upon the completion of their studies suggest there is no difference between candidates in places 1 to 100, and 150 to 400 in the ranking of the admissions committee. Thus, the admissions committee does not predict academic achievements, at least not for places 1-400. It appears that in each yearly intake, we are missing out on 150-300 potential doctors that could have achieved well academically had they been trained in Israel, although we cannot be certain about their inter-personal capabilities, as they had been rejected by the admissions committee. This figure is consistent with the literature, which shows that the PREMED students achieve similar results to graduates in the direct medical programs.11 This information evokes ethical and social questions regarding the mechanisms for admission, including the PREMED programs, and their implications on the medical profession. It appears that many countries are losing good and worthy candidates, who would have likely graduated from medical school as successfully as their peers, but who missed out on this opportunity.14

If we revised the admission scheme and accepted all medical candidates through a PREMED program, we could have had a yearly intake of 400 students. However, because placements for clinical training would still be limited, it would be necessary to employ some form of selection at the end of the three years and before admission to the clinical years. Academic grades by themselves appear to be an inadequate selection tool, and therefore, interviews and personality tests will still be required. Eventually, the same group of candidates might miss out on medical training, and this proposed admission scheme would have no advantage over the existing one. Furthermore, this lengthy process might discourage candidates who would not be motivated to join such a program.

In summary, the PREMED track that we trialed as a pilot program for three cohorts was fundamentally different from PREMED programs in other schools throughout the world. We aimed to provide a separate program, enhanced by a research component, that would form an alternative pathway into medical studies. The program was achievement-based and designed for eligible candidates who met the threshold criteria but were not admitted to medical studies because of the limited number of places. Eventually, the program was not fully executed, and the changes introduced each year practically abolished it. However, we thought it was worthwhile to present the results of this pilot program. Now that the graduates of the three cohorts have completed their medical studies, a retrospective examination of their academic achievements can be used to learn about medical school candidates, and particularly those who are not accepted into the medical program. The study also allows us to evaluate the wider implications of the admission processes.

We believe that the results of our study, which are consistent with international findings, should provoke further discussion and consideration of the significant potential loss of human resources. One of the obvious conclusions of our study is that the PREMED program should be reinstated. This will allow candidates who are determined to study medicine, and meet the required academic threshold, to prove themselves, despite them being rejected by the admissions committee. Admission to the PREMED program would still depend on interviews and personality tests, which would exclude candidates who present with substantial personality barriers that are incompatible with the image of a medical doctor. It appears that additional admission tracks could provide alternatives, creative options for admission, such as a community-oriented track, a research-based track, and others. The additional tracks would be invaluable in maintaining eligible candidates and influencing their education and training in local medical schools, rather than accepting them into the health system after they had completed their studies abroad. Furthermore, additional admission tracks could potentially retain candidates who would otherwise give up on their medical aspirations and choose a different career.