
Effects of Gender and Age on Students' Performance in Adjustive Technique Classes

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Physical manipulation in the form of spinal adjustments is the primary form of treatment offered by chiropractors. Entry requirements and teaching methods outlined by the Anglo-European College of Chiropractic (AECC) have to ensure that students are selected and trained in a way that will allow them to eventually leave the college as a group of competently skilled practitioners. If significant discrepancies in the adjustive performance of different student groups are found, alterations to the present selection process and teaching methods will have to be considered. The purpose of this study was to establish whether gender and age have any effect on students' performance in adjustive technique classes. A retrospective different subject design was used and the study was carried out at the Anglo-European College of Chiropractic. The performance of 183 mature entry students and 96 standard entry students belonging to three successive 3-year classes was analyzed. The sample consisted of 158 males and 112 females, with ages ranging from 21 to 53 years. Information from the 279 students was obtained from the AECC registry office. The data consisted of anonymous lists which yielded age, sex, and the grade point average (GPA) for adjustive technique classes of each student. Students of 25 years of age and over were considered to be mature entry students and students under the age of 25 were regarded as standard entry. These were further subdivided into four age-group categories. An unpaired *t*-test was used to determine gender differences and mature versus standard age student differences in GPA scores. A one-factor ANOVA was used to determine whether GPA scores differed among the four age groups. To aid interpretation of the results, an informal interview about performance criteria was conducted with faculty involved in the assessment of adjustive technique. At a probability value of $p < 0.05$, no statistically significant difference was found between the adjustive performance of male and female students. The male mean GPA was 68.4% (± 4.4 SD) and the female mean GPA was 67.8% (± 3.6 SD). Similarly, no statistically significant difference was found between the mean GPA for mature entry students (68.4% ± 4.0 SD) and the mean GPA for standard entry students (67.7% ± 4.4 SD). The ANOVA applied to the four different age groups established that students belonging to an age range of 25–29 years had a significantly higher mean GPA. An extensive literature review regarding the effects of age and gender on students' performance appeared to suggest that differences between student groups may exist. This was not reflected in the present results. However, it was suggested that a variety of factors which were not taken into consideration during the study design may have been responsible for this outcome. Follow-up studies are therefore needed. (*The Journal of Chiropractic Education* 13(2): 114–130, 1999)

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INTRODUCTION

The Chiropractic Adjustment

The chiropractic adjustment is a short-lever, high-velocity, low-amplitude impulse into the

paraphysiological space of a joint. Students at the Anglo-European College of Chiropractic (AECC) are first introduced to adjusting in the 2nd-year technique laboratory. Initially adjustment setups are used to teach the positioning of doctor and patient for each adjustment and special emphasis is given to the location of contact point, the joint prestress, and the direction of tissue pull and line of drive. To a lesser degree, impulse and thrusting exercises are

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taught to train the student in performing the actual dynamic impulse used on patients. During laboratory classes and assessments, students are required only to perform the setup of an adjustment. However, the correct prethrust tissue tension has to be achieved and a mock impulse with little depth added.

The acquisition of adjustive skills requires a high degree of learning from the *psychomotor domain*. According to Good (1), this has to be integrated with a certain amount of learning from the *cognitive domain* as well as with aspects of learning within the *affective domain* (which includes considerations for issues like motivation, reinforcement, and attention).

Psychomotor Skills: Acquisition and Development

The term “psychomotor” refers specifically to activities which have to do with voluntary movement. Good (2) quoted Gagne (3), who refers to psychomotor skills as unitary motor acts which are elements that make up part of a more comprehensive activity, such as skiing or playing soccer, or, as is the case with chiropractic, performing an adjustment. Additionally, Good (2) provided a definition for this skill as “the ability to perform an act in which the receptor–effector–feedback processes are highly organized both spatially and temporally.” This emphasizes the role of the nervous system in the performance of a skilled task. The acquisition of a skill is the result of facilitation by the nervous system, and is thus not only dependent on the environment in which the skill is learned, but also on the inherent psychomotor skill learning capacity of the students. Higgins (4) noted that skill is relative to the individual in every sense of the word: his or her size, scale, point in development, cognitive ability, fitness level, and degree of competence and confidence. There are important considerations when a student’s adjustive performance is evaluated.

Learning a psychomotor skill takes place in several stages which Laskley, quoted by Good (5), termed “the stages of *exploration*, *adjustment* and *fixation*.” During the first two stages, the student grapples with a new task through repetitive trial and error, until finally the correct pattern is imprinted during the fixation stage. Higgins (4) emphasized that the early stages of skill learning are characterized by a high degree of cognitive-conscious involvement on the part of the learner, who has to understand the nature of the motor problem to be solved so that a coordinated pattern of movement

can emerge—one that is maximally compliant with demands imposed by biomechanical, anatomical-physiological, and environmental variables pertinent to the task.

Approaches to Teaching and Learning a Psychomotor Skill

It is hoped that the brief insight into psychomotor skill acquisition given above emphasized that the type and extent of the problems encountered in learning an adjustment may differ significantly among individual students and are likely to affect performances to varying degrees. Furthermore, it should also give an impression of the high demands imposed on those who are meant to aid the skill acquisition process.

According to James (6), a psychologist specializing in training and skill development, the instructor is the “unsung hero of the skill development process.” The instructor has to be actively involved in the performance of the skill and as the development of the skill goes through specific stages, differing instructor behavior is demanded for each stage. If instructor behavior is not linked to the stage of the skill, the skill development will break down.

Good (1) also emphasized the impact of good teaching strategies on manual therapy technique performance and likened them to the effect a good coach has on athletes. He drew particular attention to focusing on bad habits that a student may often develop during early stages of skill development, as those are potentially harmful to doctor and patient and once ingrained are difficult to overcome. Monitoring performance and correction are important training tools; however, using them correctly is a subtle skill. *How* the instructor provides feedback can boost trainee confidence or destroy it (6). Thus it is important that as a teacher of adjustive skills, one has both an understanding of the skill process and an understanding of the training process.

Strategies

Over the past decades there has been widespread interest in how students learn and in the type of strategies they employ to access and retain information (7,8). Likewise, motor behaviorists have also appreciated the tremendous impact cognitive strategies might have on learning and mastering complex psychomotor acts.

Singer and Chen (9) proposed a classification scheme of the various types of cognitive strategies that can be employed for the acquisition of

psychomotor skill. For example, an important distinction is whether a strategy is *externally imposed* or *internally generated*. An externally imposed strategy is provided by an expert—the student is directed as to what to do and how to do it. When students learn how to adjust, they initially rely on externally imposed strategies. However, after sufficient experience, mainly based on trial and error, they can apply self-initiated (internally generated) strategies which are often more effective and generally preferable, simply because a mentor cannot always be available to provide guidance.

Singer and Chen (9) further classify strategies according to the goal at which they are aimed. Consequently, one needs to distinguish between *learning* and *performance strategies*. Learning strategies contribute to the acquisition of skill, whereas performance strategies contribute to the production of what has been learned on evaluative occasions. As the authors rightly pointed out, it is one matter to acquire some knowledge and skills, but another matter to produce them effectively in various evaluative contexts (e.g., in a classroom test). Ideally, performance level would match true proficiency, but performance may fall short of reflecting status, especially in demanding and stressful situations. However, if learning strategies contribute to the efficient processing of transient information into a more permanent store, then such information could be accessed more easily in a performance situation.

One way of achieving this is the use of a *chunking strategy* which groups elementary components of a motor skill into a larger pattern. This allows packing more information into one unit and lends more structure to the acquisition process, which increases its efficiency. Good (1) referred to this as hierarchical organization, where units of movement (*subroutines*) are strung together under a so-called *plan* to perform the skilled act. Thus each adjustment or technique constitutes a plan made up of several subroutines such as adjustment setups (ASU), thrust, and impulse. Within each are smaller subroutines, for example, the ASU consists of doctor's position, patients' position, contact point, etc. Each of the smaller subroutines are taught independently and then incorporated into larger subroutines and eventually into the plan. Good (1) believed that fluidity and smoothness of the act would be achieved once many of the subroutines have become automatic. However, during the practice of subroutines it is extremely important that the plan itself is firmly implanted in the student's mind, so that he or she has

a strong appreciation of the final product. Otherwise fluidity and smoothness will not be achieved and, despite correct subroutines, the end product will fail. Nonetheless, despite such potential difficulties, chunking strategies are one way to facilitate the learning and teaching of an adjustment. However, there are further strategies that can aid the acquisition of a motor skill.

Interhemispherical Approach

The outcome of a study by Fairweather and Sidaway (10) suggests that the majority of students learning psychomotor skills should benefit from *interhemispherical teaching strategies* (ITS). This is based on the widely known theory that the cerebral hemispheres possess dominance for specific processing abilities. The right hemisphere is thought to process information holistically and to function nonverbally. It is also believed to be heavily involved in manipulospatial tasks. The left hemisphere, on the other hand, is thought to be more analytical and primarily responsible for verbal functions, and also for sequential motor control. It is thought that 75% of the population use both hemispheres to the same degree, but at different times depending on the task at hand.

Fairweather and Sidaway (10) proposed that most people should benefit from ITS in the acquisition and retention of a motor skill, as this process involves both hemispheres. In their experiment, subjects were divided into three groups and taught golf skills, using left or right hemisphere teaching strategies (LTS or RTS), or they were taught through ITS. Analysis of the results showed that ITS and RTS groups performed almost identically during motor skill acquisition. However, the RTS group had problems recalling the task in the retention test, a difficulty that was not encountered by the ITS group. Verbal instructions which were used in the LTS group emerged as the least effective in the acquisition and retention of the golf skill.

If Fairweather and Sidaway's (10) results are reproducible, the implications of such teaching strategies will be tremendous. Since 75% of the population are thought to be nondominant processors, most students would benefit from ITS, especially when ITS is incorporated into the chunking strategies suggested previously.

Imagery and Mental Practice

Motor tasks that have a highly cognitive element are thought to be strongly influenced by mental rehearsal or imagery (11). This involves the formation

on the mind of visual (i.e., seeing the task in your mind) and/or kinesthetic (i.e., feeling the movements) images of the behavior that one wishes to learn. The more complex a motor task, the greater is the cognitive input required and the more it is believed to be affected by mental imagery.

However, depending on the type of imagery that is being used, the inference is not necessarily beneficial. For example, a study by Woolfolk, et al. (12) investigated the effects of positive and negative imagery on motor skill performance, which in their study involved putting a golf ball. Prior to performance, all subjects, apart from those used for the control, were instructed to imagine the backswing and putting stroke. Subjects in the positive imagery group imagined the ball going into the cup, while subjects in the negative imagery group were asked to visualize the ball narrowly missing the cup. Subsequent analysis of the results revealed that the positive imagery group produced the most improvements, the control group produced less, and the negative imagery group resulted in performance deterioration.

A review of recent studies in imagery and motor skill performance by Hall et al. (11) showed that imagery is particularly useful for motor tasks that involve knowledge of certain principles of physics or other sciences. This would make the chiropractic adjustment an especially suitable candidate for the incorporation of imagery. Indeed two studies within the chiropractic field have revealed interesting results. Josefowitz et al. (13) compared the effects of different types of mental images on adjustment performance. Interestingly, a pilot study had revealed that students spontaneously either imagined the spine that they were working on or imagined themselves performing the adjustment. Thus it was decided to investigate whether both images were equally successful in assisting students' performance on learning a new adjustment. The results suggested that using the spine as a mental image led to the greatest improvement. However, it is important to note that students in this group were not only asked to picture the spine, but furthermore to envisage the positive outcome the adjustment would have on the respective structures. Thus it was probably the use of positive imagery that led to greater improvement. Also, as was revealed in the discussion, the mental rehearsal group had achieved much higher pre-experiment scores than the imagery group, which probably left less room for improvement. Still, Josefowitz et al's (13) study has interesting implications for the acquisition of adjustment skill.

A study by Stig, et al. (14) compared the effectiveness of physical practice with mental practice in the learning of chiropractic adjustive skills. This had the advantage that the physical practice group could essentially be seen as a control group [an experimental aspect that was missing in Josefowitz et al.'s (13) study] and thus a more accurate comparison could be made. The results indicated that under the condition of the experiment both methods were equally efficient. However, considering that the mental practice group had no physical practice at all during the experiment and in light of outcomes from previous studies on mental practice and motor skill acquisition, it is probably fair to assume that a combination of both mental and physical practice would yield the best results, and this should be emphasized in the teaching and learning of an adjustment. It is important though that the instructions outlining such an approach are given to the performer in sufficient detail to ensure that he or she is imaging the task in the appropriate manner (11).

Chirobics

Another way to encourage motor skill acquisition is to make the learning process more attractive and fun. This is particularly important when extensive practice is required in order to achieve adequate skill performance.

An important aspect of the chiropractic adjustment is the thrust or impulse. To master this skill, students are taught various chiropractic thrusting exercises (CTEs) which they are encouraged to practice regularly, inside and outside the classroom. However, it is a common observation that a certain amount of boredom does appear in class with the repetition of these exercises. In an attempt to alleviate this problem, Good (15) developed a new teaching method named "Chirobics," which involved performing the exercises to contemporary music.

Chirobics was introduced to a class of 2nd-year students where it was then used as the only method of practicing thrusting exercises in class. Students in the year above continued to perform the CTEs as they historically had always been taught: mimicked repetitions of the instructions and performance by the tutor. After a period of several months, students' attitudes towards the two methods were assessed. The results revealed that students generally enjoyed Chirobics more than CTEs and that women in particular enjoyed Chirobics more than men did. This, Good (15) believed, was most likely a result of its similarity to dance. Still no indication was found

that students would practice Chirobics more often than CTEs. It is probably unfortunate that Good (15) did not assess whether Chirobics led to greater improvement of thrusting performance as compared to CTEs. Nonetheless, students' enjoyment of a certain teaching technique is an important consideration and ideally should always be considered when a new method is implemented.

Problems and Attitudes

A paper by Beal (16) on osteopathic manipulative techniques emphasized a further aspect that teachers should know. During their training, students are not only required to learn a considerable number of adjustments, but also several different types of technique. This often results in students becoming overwhelmed by the mere quantity of material to be learned rather than appreciating that there are basic principles that are common to all procedures. It is thus important to help students understand these basic principles so that they can be taken and modified, not only according to the respective techniques, but also according to the unique circumstances in which they are applied in patient care.

In 1993, Good composed a questionnaire to gain insight into students' attitudes on a variety of topics. For example, students were found to have relatively high opinions about the practice of thrusting exercises which, according to Good (15), coincided with the observation that chiropractic students have good attitudes towards most aspects of technique laboratory. It was interesting that mature students had statistically better attitudes than younger students and this increased with age. Good (15) felt that this could have been a reflection of the greater commitment often exhibited by mature students to their chosen field of study, a view which is supported by another finding indicating that older students favored an increase in practice relative to younger students. The author explained this to be most likely due to the observation that younger students are quicker to learn psychomotor skills, and thus feel they require less practice. One item in the questionnaire asked students to rate their psychomotor ability relative to the others in the class. It came as no surprise that men showed a higher opinion of their psychomotor skills. Although it is very tempting to ascribe this result to the "male ego," Good (15) pointed out that it is commonly accepted that in general men have slightly greater psychomotor ability than women. However, one would like to remark that it is also widely known that females have an apparent lack

of self-confidence in physical activity compared to males who often display "boastful" behavior (17).

Furthermore, if women rated their psychomotor ability lower due to an existing, albeit small, lack in skill compared to men, one could argue that this perceived inadequacy should lead to a stronger desire to practice more, as was found to be the case for mature students. However, no significant difference between men's and women's attitudes towards an increase in practice was found.

Kleynhans (18), in his essay on motivation and learning, pointed out that when a person perceives a gap between the perceived self-in-the-world and the concept of the adequate self, a motivational state develops to embark on a course of action which is believed will eliminate the difference. The author further emphasized that the quality of a student's self-concept is of decisive importance to his or her approach to individual subjects and is a precondition for the experience of success. The experience of success, indeed, is a major motivating factor in itself. Thus the mistake should not be made to assume that all motivation is borne out of feelings of inadequacy. Success gives students a sense of personal achievement that will provide motivation for further learning and encourage greater risk taking. It is Kleynhan's (18) view that teachers should be aware of the different levels of self-esteem and motivation that exist among students, and that this awareness should aid them in organizing learning and in setting objectives in a way that will create an optimum classroom climate.

Physical Requirements Made on the Adjustor

In 1990 Haas published a number of articles on the physics of spinal manipulation (19-22). He demonstrated that the average adjustive force can be expressed in terms of kinetic energy (*mass* and *velocity*) of the doctor, and the combined mechanical resistance to deformation (*stiffness* and *elasticity*) of both doctor and patient.

Haas's (19,20) model was based on the assumption that the only source of incoming energy was the impact kinetic energy of a physician's body drop. Maximum adjustive force is thus achieved with increased doctor's weight, decreased elasticity of doctor and patient, and when the doctor's impact velocity is increased. Haas (20) emphasized that his force equation could be generalized to other manipulative procedures as long as other sources of energy are considered. Such sources include the work done

by pectoral, triceps, and abdominal muscle contraction. Nonetheless, an adjustment does not depend on the generation of force alone. In the third paper of the series, Haas (21) isolated several additional factors relevant to the successful execution of an adjustment. Quickness and control of the depth of the adjustment (*amplitude*) are also key psychomotor skills. Moreover, *countertension* to aid joint distraction and *preadjustive tension* to limit dispersion of force and energy into structures other than the joint of interest will help to achieve the desired outcome. Preadjustive tension in itself depends on mass, and Haas (20) concluded that impact velocity along with mass are the explicit extrinsic variables governing the adjustive force.

Gender and Age Differences

Physical Capacity and Psychomotor Performance

Keeping in view the physical requirements on the adjustor described above, it could be argued that women in general are at a mechanical disadvantage which is not caused by inadequate psychomotor abilities but merely a result of being lighter and possessing less muscular force than men. Indeed, a longitudinal study by Barnekiw-Bergvist et al. (23) on physical capacity in adolescence and adulthood offers support for such an assumption. The authors investigated the development of muscular endurance and strength from the age of 16 to the age of 34 and found, in accordance with previous studies, that muscular endurance and strength were lower in women than men, both at the age of 16 and at 34, and that these differences increased with age. While men generally increased their performance, women's performance remained unchanged or had even decreased at the age of 34.

Although such findings suggest that women, and female mature students in particular, may be disadvantaged as far as certain physical properties of the adjustment are concerned, the consequence need not be that they will be less successful adjusters. It does, however, require them to make up for lack of physical stamina by increasing their adjustive finesse. This, for example, can be achieved by increasing the speed with which an adjustment is carried out (16,19–22).

Speed of performance is a frequent outcome variable used when effects of age and gender on psychomotor performance are assessed. Mazaux et al. (24) looked at the effects of age, gender, and education

on visuospatial attention and on psychomotor performance in elderly community residents and found that greater age and female gender were both associated with lower performance. However, the mean age of their subjects was 72–79 years and it remains unclear whether these results are of relevance to the age groups investigated in the present study. There is some evidence, however, that this may be the case. Ruff and Parker (25) found similar trends in a much wider subject range. Their sample could be subdivided into four different age groups between the ages of 16 and 70 years. Subjects were assessed on the *Finger Tapping Test* (FTT) which measures motor speed and on the *Grooved Pegboard Test* (GPT) which measures both motor speed and hand-eye coordination. Their results revealed that although women were substantially slower than men on the FTT (with this difference increasing with advancing age), women's times on the GPT were considerably faster than men's. Since GPT scores were also influenced by educational background, Ruff and Parker (25) suggested that the GPT required a certain amount of higher level executive functioning. Based on these findings, it could be reasoned that gender differences are more pronounced in basic psychomotor tasks. Since the chiropractic adjustment is a very complex psychomotor skill and requires a high level of cognitive input (1), one could theorize that gender differences should be less pronounced.

Confidence and Competitive Behavior

It is generally accepted that confidence is an important variable that influences motor performance. According to Lirgg (17), it has been a recent concern of some researchers in sports psychology that females show an apparent lack of self-confidence compared to males concerning physical activity. A lack of confidence decreases the likelihood that one will choose to do activities in a particular area and also leads to a decrease in one's persistence and effort in the face of difficulties, thus limiting the opportunities for improved performance (17). Lirgg (17) conducted a meta-analysis of recent studies concerned with self-confidence in physical activity and gender differences. It appeared that within the literature several explanations were provided as to why such different confidence levels exist. For example, one reason suggested was that males are more boastful (i.e., they overestimate their performance), but on the other hand it was suggested that the differences could be due to female modesty (i.e., women's tendency to underestimate their physical abilities). Lirgg (17)

could not find any evidence, however, that competition affected confidence levels differently in men and women. However, even if confidence levels are not affected by competition, competitive situations can still have a significant influence on an individual's performance (26), with men tending to perform better in a competitive environment, while women perform better during cooperative situations.

Due to the manner in which adjustive skills are assessed at the AECC, this is a finding of some significance. Throughout the 2nd year, for example, students are assessed in groups of four with two students at a time acting as "doctors." This type of arrangement could easily create a competitive atmosphere and thus influence students' performance levels.

Cognitive and Affective Considerations

Although adjustive skills depend most heavily on a student's psychomotor abilities, they also require a considerable amount of cognitive input. Knowledge of theories and principles, including didactic concepts such as contraindications, complications, and serious alternative procedures, are important if an individual is to become a truly accomplished practitioner (1). During an assessment, the student may be required to reason why a particular adjustment is used and has to show knowledge about the anatomical and mechanical aspects of the adjustment procedure. This background knowledge is mainly supplied in theory lectures and in the technique laboratory and requires conventional learning strategies in order to be processed.

It is perhaps unfortunate that this and many other aspects of chiropractic education, including gender and age-related differences among students, have found little consideration in the chiropractic literature to date. To draw comprehensive conclusions from the performances measured in chiropractic students, one is thus required to consult literature from related fields so that the necessary background can be established. Extensive information on factors that predict and influence students' performance has been gathered in the medical literature, which consequently becomes a leading source of reference. To use this information, however, one has to ensure that there are sufficient similarities between chiropractic and medical students to ascertain that the results obtained from medical school studies are relevant.

Nyiendo, et al. (27) used the Myers-Briggs Type Indicator to evaluate chiropractic students for specific psychological types and subsequently compared

them to other health professionals. The results indicated that both physicians and chiropractic students showed a preference for intuitive perception as opposed to sensing perception. The authors felt that this was appropriate since both groups need a broad perspective of illness and health care and an understanding of the subtle relationships between health, disease, and the whole person. Additionally, no difference was found on preference of "feeling" over "thinking" between female chiropractic students and other health care professionals. However, male chiropractic students had a majority of "thinking types," while "feeling types" were generally more common in other health care professions.

A smaller study by Peel-White, et al. (28) assessed students at the AECC on a questionnaire based on several different personality scales. It was found that the student population approximated the personality type normally associated with medical school, which is one considered at risk from stress-related psychopathology. Although Peel-White et al.'s (28) conclusions were tentative in light of the small sample size, they render further support for the use of medical education studies, particularly so since the student sample under the present investigation is also from the AECC.

Gender and Age Differences--Academic Performance

Numerous studies have been carried out in medical schools in an attempt to delineate those factors or personal qualities which determine the best physicians. According to Entwistle and Brennan (29) there are a variety of paths that lead to either success or failure. Entwistle et al. (30) found that next to study methods (including learning style and approach), motivation showed significant correlation with academic success. This was later confirmed by Rhoads et al. (31), although they felt that motivation was the determining factor for students' performance.

As stated by Shen (32), it is known that medical students' level of achievement is influenced by both student characteristics and the characteristics of the school they attend. Shen (32) analyzed student performances in Part I, II, and III of the National Board of Osteopathic Medical Examiners (NBOME) to look for the existence of gender effects. The results revealed that men performed better than women in Part I, while performance was equal in Part II. In Part III women outperformed the male

students. Similar findings have been reported in other studies (33,34). According to Shen (32), the gender differences did not vary among different schools, however, they could not be used as strong predictor for osteopathic medical students' performance. Further, gender ratio as a school characteristic did not contribute to the achievement differences, and since the same gender differences were found across different schools, Shen (32) suggested that gender influences medical achievement independently from organizational factors. According to the author, the repeated findings that gender differences reverse direction during medical education allows one to speculate that women and men have different growth patterns and that female students grow relatively faster than male students within the current medical education system. However, one also has to consider the content of each part of the examination. During Part I, students are assessed in basic sciences, while Parts II and III have an increasingly more clinical content.

Walton (35) found that female medical students were more competent than their male counterparts when measured on examination success, essay abilities, and clinical skills. Only when their physical exam skills were assessed did both groups perform equally. Walton (35) also assessed students for personality differences and noted that females were more anxious and introverted, and generally less emotionally stable than males. Additionally, there was some indication that women who displayed particularly high degrees of anxiousness were the most superior in academic performance. Linn and Zeppa (34) felt that women may feel more stressed than men because they are generally under a greater strain than men as they often have to combine the dual role of professional (or student) and wife and mother. The authors related this to the much greater suicide rate found among female physicians when compared to their male counterparts, a third of these suicides occurring among those still in training. However, according to Eisenberg (36), when these rates are analyzed within the limits of statistical reliability for uncommon events, the calculated suicide rates for female physicians are about the same as those for male physicians.

Walton (35) further investigated gender differences in medical students' attitudes and found that more men than women felt that their teachers gave them insufficient guidance. This, of course, could be interpreted in various ways. It may be that female students receive more attention from their teachers

than male students, or that they are more self-sufficient. According to Walton (35), women also seemed to be more ready to have their knowledge and skill tested, while some men regarded examinations as an impediment to their study. Although Walton's (35) study offers a series of interesting results, one has to question its present-day value. Thirty years ago, female applicants to medical school were still less acceptable than men and fewer gained entry. Thus it is reasonable to suggest that the small female quota that was admitted consisted of particularly competent women who were probably more intelligent than their male counterparts. Concerning the anxiousness and introversion that was displayed by the female students in Walton's (35) study, one can assume that with growing numbers of women in medical education women have become more confident and extroverted than they were in the 1960s.

Huxham, et al. (37) applied factor analysis to identify achievement factors and link them to personality traits in a cohort of medical students. It was revealed that emotional maturity, good reading comprehension, and good general mental ability were characteristics that contributed to overall achievement. Green et al. (38) could not establish any relationship between academic performance in the final examinations and either sex, age, or grades obtained on first attempt at A-level. In contrast to Huxham et al's (37) study, the authors also failed to establish a link between academic success and personality factors. However, it was pointed out that this could partly be explained by a lack of academic discrimination, since the only marks that were available for investigation were either *pass* or *fail*. Thus there was little choice to which personality factors could be attached. Nonetheless it is a surprising finding when viewed in the context of other studies. Alfayez et al. (39) also found that gender had no influence on medical school grade performance, although it appeared that women's performance was more influenced by changes in their living environment. Furthermore, in contrast to Green et al.'s (38) study, there did seem to be a relationship between high school grades (comparable to A-level grades) and performance. Students who were motivated only by social gains, financial benefit, or family wishes performed significantly lower.

In essence it seems that at least in certain areas within medical education some gender differences do exist, although they may not be as severe as previous studies suggested. Nevertheless, clarification is needed as to whether the differences between

women who are physicians and men who are physicians stem in any important ways from traits inherent in biological gender or social upbringing. Although it is assumed that feminine qualities like nurturing, person orientation, and sensitivity enable women to make special contributions to health care professions, Eisenberg (36) pointed out that female physicians more nearly resemble male physicians in professional attributes than they do other women in the population. According to Eisenberg (36), this is mainly due to the selection and admission procedures used at the respective universities since the same criteria are applied to male and female applicants.

The preoccupation with the differences between men and women is as old as culture. It comes as no surprise that this is reflected in the vast number of studies that have investigated gender differences in all areas of life. Although age differences per se have also been studied in great detail, the emphasis is usually placed on either side of the continuum (i.e., children and elderly) and to a lesser degree on the midrange to which standard entry and mature students belong. Nevertheless, with working life extending into older age groups and with the necessity to regulate admission procedures, differences between mature and standard entry students have found some consideration in research. Harth, et al. (40) carried out a detailed study on mature medical students to isolate sociodemographic characteristics, career choice, and job satisfaction. Mature entrants were on average 7 years older than normal entrants and the authors could establish little or no significant difference in terms of gender, marital status, number of children, and ethnic background when both groups were compared, although a greater proportion of mature students were married with children. Seventy-six percent of the mature age entrants had already completed degrees, with more than half of these degrees in health science areas. According to Harth et al.'s (40) results, mature students experienced greater stress throughout the course, especially with regard to financial difficulties, family problems, loneliness, and isolation from fellow students. While whole-course grades were similar in both groups, normal age entrants tended to win more undergraduate honors, prizes, and postgraduate diplomas, including special qualifications. In general, mature-age students are said to be better motivated and perform better in medical school. An evaluation of the grades of British medical students during preclinical years by McManus and Richards

(41) showed that mature-age students had a better overall performance. Also, Green et al. (38) found that students who had already obtained a degree, which is the case in many mature entrants, experienced less academic problems. On the other hand, those mature students who have not acquired degrees prior to entry may lack confidence compared to their colleagues, particularly if they experienced difficulties during the admission procedure. Wakeford (42) studied the response of U.K. admission offices to a query from a potential mature applicant with good science A-levels. It emerged that 26% tried to discourage the applicant, while another 26% stated mixed feelings or said they were unable to advise her on the future. Disheartening replies such as these are likely to undermine a mature entrant's confidence upon enrollment and thus may lead to a less advantageous start at medical school.

Gender Bias

Before any statement about group differences (be they gender or age related) can be made, the possibility of bias has to be excluded. Although the existence of bias in a certain testing method is a serious allegation, its probability has to be considered. Bias in testing describes differences in test results between groups of candidates where the observed differences are unfairly related to group memberships. To establish that a test bias exists, one needs to distinguish between group differences in overall ability and group differences after the groups have been matched on the basis of the ability the test supposedly measures. Rothman, et al. (43) applied *Differential Item Functioning* (DIF) procedures to data from 23 clinical skills stations used in the selection of candidates for the Ontario Pre-Internship Program. DIF analysis is based on the following principle: If a difference in item performance between two groups of examinees who have been matched with respect to the construct being measured by the test is found, the term DIF is applied to this difference. Thus it is the size of the value that is obtained after DIF procedures have been applied to such a matched sample that will indicate whether a significant bias exists in the test under study. The results obtained in Rothman et al.'s (43) study suggested that of the 23 stations that were investigated, more were biased in favor of men than vice versa. Nonetheless, of the two stations with the highest DIF scores, one was in favor of men but the other was in favor of women.

In this context it was pointed out by the authors that when a high DIF score is obtained, one has to establish whether this is due to true bias or rather caused by *differential gender relationships*, in which case a high score is acceptable. The station with a high DIF in favor of men required students to perform a physical examination of a 20–40 year-old man who had just suffered from a disc herniation. Here, according to the authors, the exclusive use of male patients may have been the cause of the DIF, in which case it should be viewed as a biasing factor. In contrast, the station with the high DIF in favor of women required candidates to interview a young single mother concerned about her baby that had not gained much weight. In this case the authors felt the high DIF might reflect differential gender relationships to the station's content. Rothman et al. (43) did not explain how this conclusion was reached and one can only assume that a female candidate would naturally find it easier to interview the young mother, due to her own innate maternal instincts—a slightly dated belief it seems, in view of the increasing numbers of nulliparous professional women. Nonetheless, the need to distinguish between normal differential gender relationships and true bias is a valid point and has to be considered when examination outcomes are assessed for gender differences.

In 1991 five U.S. Chiropractic colleges came under scrutiny in a survey by French (44), who looked for objective gender bias reflected in adjustive technique class grades as well as subjective bias reflected by teachers' considerations in grading. Significant pro-male bias was found in two colleges. Additionally, two out of 18 interviewed teachers admitted bias against female student-adjusters. When tutors were asked to comment on what qualities make a good adjuster, the most frequently mentioned desirable qualities were: athletic ability, strength, and mass or size, all of which are characteristics that are commonly associated with males. Other less commonly used words were: outgoing, aggressive, coordinated, concentrated, and kinesthetic. Mentioned as undesirable qualities were hesitancy (due to sensitivity of patients) and predilection to adjuster injury. Both of these qualities were attributed to females.

However, French's (44) study had several flaws. Most significant probably was that her claim of a pro-male bias in technique classes was not correct, as in several cases colleges had supplied her with combined grades, consisting of written as well as

practical examinations (45,46). Wittmer (46) specifically pointed out that at Logan college, which had been taking part in the survey, women did significantly better on the practical portion of their exams than they did on the written portion, and in many cases had shown higher grade point averages than their male fellow students. Nevertheless, the insight that French's (44) paper provides into criteria used by tutors when adjustive skills are evaluated is interesting and useful. Furthermore, French (44) warns about the dangers that a predominantly male population at chiropractic colleges can imply: Not only may it predispose instructors to evaluate females by what may be inappropriate criteria, but it can also predispose to teaching methods which may be injurious to female adjusters.

Practical Examinations

The article by French (44) shows that fair and valid assessment of student achievement in clinical task areas can be a major problem facing instructors in all institutions preparing students for various health care professions. The difficulties in providing unbiased evaluators is just one of many problems. Further issues are the inordinate amount of time required to evaluate students individually, the difficulty in providing evaluators with adequate numbers of specific performance standards by which to judge students, and the inability to provide adequate samples of performance given time constraints.

Sandefur and Burk (47) addressed yet a further problem. According to the authors, students had frequently complained that there is a time-related effect upon test scores, with students among the last few being tested having an advantage in terms of resulting test scores, due to examiner fatigue and boredom, among other causes. This claim was investigated by subjecting cumulative grade point average (GPA) and time-of-test-taking to statistical analysis. It emerged that late test taking did indeed improve scores, particularly those of low GPA groups. It is thus of vital importance that students are assigned randomly to time slots when their adjustive performance or other skills are assessed.

Summary and Aims of the Study

A review of the recent literature has shown that a diversity of factors influence the acquisition and performance of psychomotor skills. During the learning stage, various strategies are available to the

student which need to be emphasized by the teacher to aid the acquisition process. The complexity of the adjustive skill allows for this process to be divided into several subroutines which, initially, can be taught and learned individually. Furthermore, there is evidence that imagery and mental rehearsal may help to speed up skill development. In addition, designing an environment which makes practicing a psychomotor skill more attractive is likely to increase the desire to learn. On the other hand, there are many factors which exercise a far more subtle influence on the acquisition process and are thus more difficult to target. For example, great variations in confidence and motivation levels among students are likely to affect the learning outcome.

The chiropractic adjustment is based on the biomechanical properties of the body and students are required to learn and understand these theoretical principles in order to become good adjusters. Extensive research at medical schools has indicated that students can have very different styles of learning which are more or less effective in their outcomes. Furthermore, there has been some evidence that personality traits may influence an individual's academic performance. There is no doubt that knowledge of such factors aids the search for ideal learning conditions. However, in most cases this will require specific investigative methods which are often not within the limits of a college's resources. The initial target should thus be to focus on the most fundamental differences that are found within a student population. Age and gender are such obvious student characteristics and are variables that have shown to have an influence on student performance in psychomotor and cognitive tasks.

The AECC offers places to students of all age groups and both sexes. It is hoped that upon completion of the course a homogenous group of equally skilled practitioners will be embarking on their respective careers. However, if significant differences between student performances are found which are either attributable to gender, age, or both, this aim will not be realized unless appropriate changes to the selection process or the teaching methods are made. Furthermore, the sensitive issues of age or gender bias will demand consideration. In order to ensure that students, regardless of their gender or age, benefit equally from the training they receive and are assessed fairly, a study was designed to establish whether any of the differences that are

observed among the adjustive skills of different students can be attributed to either of these variables.

METHODOLOGY

Assessment of Adjustive Skills

The grade point average (GPA) for the adjustive technique final mark of each student is made up of the accumulation of three separate scores which are each obtained for approximately eight adjustments performed under evaluative conditions. During such an assessment the student is provided with a specific listing for a spinal joint "malposition" and is then required to decide on the appropriate adjustive maneuver which has to be demonstrated on a fellow student who acts as a patient. Throughout the assessment, the student may be required to show his or her understanding of the rationale on which each particular adjustment is based.

Subjects and Data

Information from 279 3rd-year students on the 4-year program at the AECC was obtained from the Registry office. The data consisted of anonymous lists which yielded age, sex, and the GPA of each student. In order to establish the influence of age on performance, students were initially divided into standard entry and mature entry students. Students of 25 years of age or over were considered mature entry students as this corresponds to an age of 23 years or over at the time of matriculation to the AECC. Entry requirements differ between standard aged students (under age 23) and mature entry students.

Due to the disproportionately large number of mature students in the sample, a further subdivision into four different age groups was made. Group 1 consisted of students 24 years of age and younger. Group 2 consisted of students between the ages of 25 and 29 years. Group 3 contained students between 30 and 34 years of age. Group 4 consisted of students aged 35 and older.

Statistical Analysis

An unpaired *t* test was used to detect both the presence of gender differences in GPA scores and differences in GPA scores between mature and standard entry students. A one-factor ANOVA was used to determine whether GPA scores differed among the four age groups. The probability value was set at $p < .05$.

RESULTS

The performance of 279 students was analyzed (158 males and 112 females). The mean age of the sample was 27.7 (SD \pm 6.0), with the range between 21 and 53 years.

Gender

Male students received slightly higher scores for their adjustive performance than female students. However, this was not statistically significant. The mean male score was 68.4% (SD = \pm 4.4) and the mean female score was 67.8% (SD = \pm 3.6). The results are presented in Figure 1. (It must be noted that a mark of 50 constitutes the minimal pass level in criterion-based assessments at the AECC.)

Age

A total of 183 subjects were classified as mature students. The remainder of the subjects ($n = 96$) were considered to be standard entry students. Mature students had slightly higher GPAs compared to standard entry students. However, this also was not statistically significant. The mean score for mature students was 68.4% (SD = \pm 4.0) and the mean score for standard entry students was 67.7% (SD = \pm 4.4). These results are presented in Figure 2.

The one-factor ANOVA applied to the age subgroups revealed a mean GPA value of 67.5% (SD = \pm 4.3, $n = 94$) for group 1 (24 years and younger). The mean GPA score for group 2 (25–29-year-olds) was 69.1% (SD = \pm 3.9, $n = 104$). Group 3 (30–34-year-olds) had a mean GPA score of 67.6% (SD = \pm 3.8, $n = 46$) and group 4 (35 years and older)

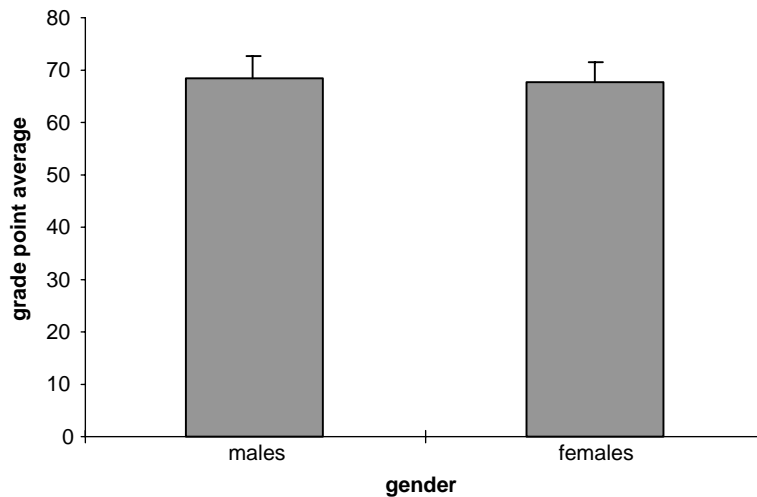


Figure 1. Difference in performance between males and females.

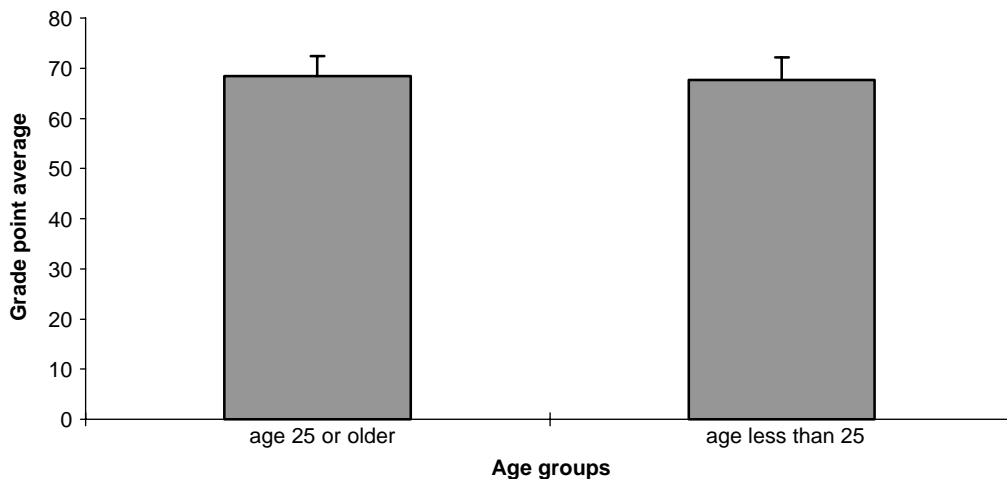


Figure 2. Difference in performance between age groups.

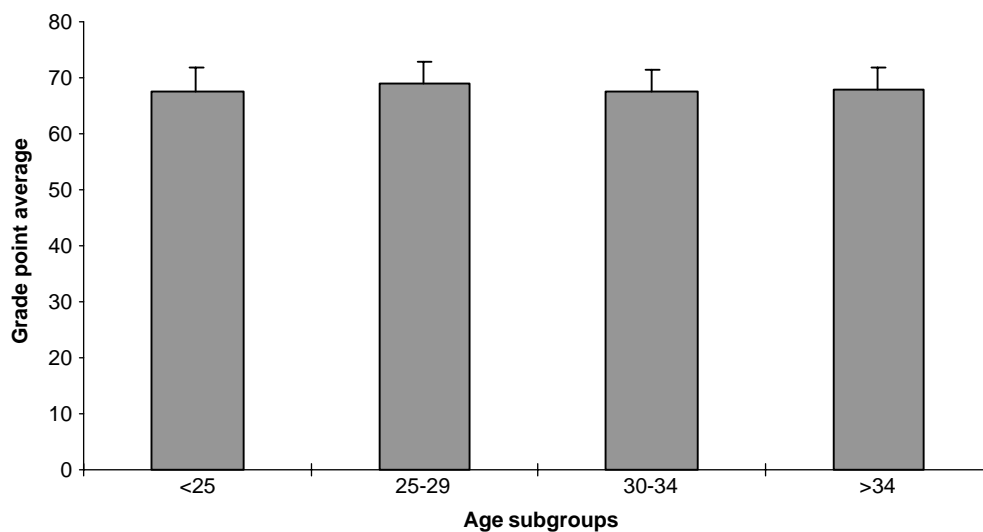


Figure 3. Difference in performance between age subgroups.

had a mean GPA score of 67.8% (SD = ± 4.1 , $n = 35$). At the p value of $<.05$ level, group 2 had a significantly higher score than groups 1 and 3. The results are presented in Figure 3.

DISCUSSION

In view of recent findings of studies conducted on psychomotor ability and physical capacity, it seemed reasonable to expect that when compared to male students, female students would exhibit lower performance standards in adjustive skills. Women have lower levels of muscular endurance and strength (23) and exhibit slower performance in motor speed tasks (25). Furthermore, they are thought to be more likely to underestimate their physical abilities and their performance may suffer due to this lack of self-confidence (17). Men who are thought to display greater confidence levels may further benefit from the competitive atmosphere which is likely to be created during the assessment. Yet, no differences were found in the present sample. To assume that no definite differences exist, however, would be a hastily drawn conclusion. A number of factors could allow students to achieve matching performance levels despite the existence of inherent differences among individual groups. First, one has to consider that only 3rd-year students were used in the study. At the AECC, students start to develop their palpation skills from the beginning of the 1st year and are taught adjustive technique throughout the 2nd year.

This provides ample time for students to work on their technique and improve their adjustive skills. If female students perceive a gap between their own ability and the standard set by male students, they may feel motivated to practice harder than their male counterparts. Alternatively, initial discrepancies in standard may be identified by tutors and successfully eliminated by targeting the weaker groups with specific instructions and guidance. Thus initially existing differences could be alleviated by the time students enter the 3rd year.

There are additional ways by which evenly balanced performance levels between groups can be achieved. It has already been emphasized that a considerable amount of cognitive input and theoretical background knowledge has to be demonstrated if one is to be rated as an accomplished practitioner (1,5). This is taken into account when a student's performance in chiropractic technique is assessed. Studies in the medical field have shown that women commonly overtake their male colleagues during their years spent in training (32–34). Although this may partly be related to the change in subject content that occurs as students progress through their medical training, it has also been suggested that the intellectual growth of women may be relatively faster than men's within the current medical education system (32). With respect to this it is possible that male students do exhibit superior adjustive skills, but that this difference is balanced by female students showing a greater understanding of the theoretical knowledge and rationale on which the adjustments are based.

Effect of Age on Performance

No difference was found between the adjustive performance of mature students and standard entry students. Since it was felt that the division into mature and standard entry students was somewhat arbitrary and not sensitive enough to reflect age-related changes in psychomotor performance, a further division of the sample into four different age groups was made.

Studies on psychomotor performance reviewed in the literature predicted a steady decline in psychomotor skills (24,25), muscular strength (23), and confidence (1,17) with increasing age. This trend was not observed in the present study. The mean score produced by group 2, the largest group, was significantly higher than those of group 1 and group 3. It is possible that group 2 falls into a category which consists of those students who are still young enough to possess excellent psychomotor skills and yet have reached enough 'maturity' to assign sufficient time to practice and study. However, in this event one would expect to find a similar tendency in the score achieved by group 3 rather than group 4, but the opposite was the case (i.e. group 4 outperformed group 3).

Nevertheless, the results suggest that either 25- to 29-year-olds are the most suitable age range to embark on a chiropractic course or that the course outline and teaching techniques employed at this college are best adapted for this particular group. At this point it may be of interest to note that the average age of 1st-year students at the chiropractic colleges in the United States appears to lie within this range, while 1st-year students within the AECC are generally younger. As far as performance in chiropractic technique is concerned, younger students (group 1) seem to be slightly disadvantaged compared to somewhat older students (group 2) who may benefit from having experienced some type of training or higher education prior to entering the AECC. Such experience may equip them with a better understanding of how to maximize their skill, be it through more effective time management and practice, greater self-discipline, or more confidence in handling oral or practical examination situations.

However, before any alterations to the minimum age entry to the AECC are made, one would have to explore whether this also applies to performance in subjects other than chiropractic technique. In general, the differences in group performance were so small that students most likely may compensate

for any lack in ability they might encounter due to their age. Thus if mature students do possess less psychomotor skill than younger students, they can level this difference by practicing harder, receiving special guidance from their technique tutors, or exhibiting a greater ability for the theoretical aspects of the adjustment.

Evaluation of Study Outcome

For the evaluation of this study, certain aspects about the data have to be kept in mind. The data consisted of a single mark only for each student and there was no indication of whether students had attended all assessments or whether there had been any failed or re-sit practical assessments. Information of this kind would have greatly improved the accuracy with which each student's performance was evaluated and may have shown greater variation in GPAs. As it was, the 3rd-year technique grades of all students were remarkably homogenous.

Another problematic issue is the decision to which degree one can make any predictions about the level of adjustive ability one may expect from different student groups in general. The data were not obtained under experimental conditions. During an assessment, students are not tested on identical adjustments. At least six different problem sheets (containing eight questions each) are circulated and picked at random. Thus comparison of different student groups becomes less clear-cut. However, the fact that the scores used for analysis were accumulated over one academic year, and that several tutors were involved in the teaching and assessment of chiropractic technique in any one year, should reflect students' ability more truly. A cumulative score is more likely to allow for "bad days" that any student (or tutor) may have suffered.

Furthermore, a standard marking sheet is used which ensures that certain key points are taken as assessment criteria. This marking sheet is made up of three sections. Section A requires the tutor to rate the examinee on *knowledge* about the rationale and the clinical application (i.e., whether the correct procedure was selected for the given problem) of the adjustment. In section B, the tutor has to rate the student's *technique* by assessing whether the correct doctor's position, patient's position, spinal contact point, contact hand, stabilizing hand, and so forth was used. Section C consists of the examiner's *impression* of the student's patient handling and

psychomotor skills per se, which are both rated on scales of 1–5.

However, comparison of completed marking sheets that have been returned to students indicates that despite these provided guidelines, it appears to be at the tutor's discretion to which degree he or she wants to pursue certain aspects of the adjustment. For example, some tutors may rely more heavily on the knowledge a student displays about a certain adjustment, while others may place very little emphasis on this aspect. Furthermore, tutors theoretically have the option to pursue certain key points to greater detail in some students than they will in others. Thus a student who exhibits a lack of ability in one area could be allowed to prove himself or herself in a different area in order to reach a particular outcome. Therefore, in view of the present results and the somewhat striking lack of variation, one has to consider the probability of tutors rating each individual within a scale that may appear fair considering each individual's group membership.

Looking at the many factors that may have influenced the present results, it becomes evident that more information is needed before any conclusive statements can be made. The obvious way to gain insight into some of these factors is to analyze the actual marking sheets that were used in the assessments. Not only would this clarify whether tutors do differ in the amount of emphasis that they place on certain features of the adjustment in general, but also whether students are assessed on different details according to their age and gender (factors which cannot be disguised during a practical examination.) Unfortunately, the marking sheets were not available for analysis, as they are routinely returned to the students for the purpose of feedback.

As a result of the above noted concerns, it was decided to ask some of the 3rd-year technique tutors to comment on whether the fact that a student belonged to a particular age group or was male or female made any difference in the way that he or she was assessed. It appeared that for all tutors the age of a student was of no relevance when performance was assessed. However, it was acknowledged by two tutors that the size of a student may be taken into account when certain adjustment setups are assessed. For example, adjustments such as a lumbar roll or an occipital lift are considered to be initially easier to manage by taller students, as their size gives them extra leverage. Although it could be argued that body height itself is a neutral

characteristic, it is obvious that men are generally taller than women. Consequently, female students are more likely to benefit when allowances for size are made. Nevertheless, one tutor in particular made it clear that gender had absolutely no bearing on how a student was assessed, as it is not thought to influence aspects such as accuracy of a student in taking up the correct spinal contact point or in indicating the correct line of drive of an adjustment.

When tutors were asked whether there were any characteristics that could be attributed to one student group in particular, there was an unanimous answer: older students displayed by far the better patient-handling skills and also appeared generally more confident during assessments compared to younger students. It is felt that this comment is of particular importance, as it may help to explain further why virtually no differences were found in the performance of different age groups. Many of the mature entry students at this college have left careers that had already required them to display good interactive skills. This superior experience undoubtedly adds to their confidence and helps their patient-handling skills. Since doctor–patient interaction receives particular emphasis in the chiropractic profession, such skills are rightfully acknowledged and rated by tutors.

Finally, it is of interest that one tutor remarked on the general reluctance of tutors at this college to award either very high or very low marks in chiropractic technique. Indeed, adjustive skills are more difficult to evaluate than many other disciplines and tutors may therefore avoid issuing extreme marks. Good (15) also remarked on the phenomenon that the results of most technique assessments are skewed far to the higher end of the grading range. He felt that this may partly be due to the pass mark being set very high, which consequently allows less scope for distinguishing between average and outstanding performances in chiropractic technique. Additionally, tutors may simply be aware of the detrimental effects that low marks could have on a student's confidence, which in turn could adversely affect their psychomotor skills. However, one must also consider that consistently high marks may give poor students a false sense of competence which, in a primary health care profession such as chiropractic, can have dangerous implications. In any case, it is believed that the reluctance of tutors to confer extreme marks for performance in chiropractic technique may have contributed significantly to the lack of variation found in the results.

Further Research

In the course of the discussion it has emerged that the outcome of this study may have been critically influenced by a variety of factors that had not been considered during the design. A follow-up study is therefore strongly suggested which should include analysis of results obtained in the 2nd-year technique laboratory. This would help to clarify whether initial age and gender differences do exist but are matched by the time students enter the 3rd year due to increased amounts of practice and commitment displayed by weaker groups. The study should further include analysis of the actual marking sheets used for the assessment. This could reveal whether students are marked on different key points depending on their age and gender. Furthermore, it would indicate whether tutors differ in the amount of emphasis they place on certain aspects of the adjustment. Alternatively one may want to consider testing a group of students on a number of specifically selected adjustments which should be evaluated by a minimum of two tutors (preferably one male and one female). This would help to further limit the amount of uncontrolled variables and improve the reliability of the evaluation process.

CONCLUSION

A comparison of the adjustive performance of students, determined during technique practical assessments in the 3rd year, revealed no differences between male and female, and mature and standard entry students. This was, as far as the entry requirements and the teaching methods in chiropractic technique at this college are concerned, a satisfactory outcome. When students were divided into four age groups, it emerged that the highest performance level was achieved by students between 25 and 29 years of age. The difference was only slight and since the discussion revealed a host of variables that could account for this outcome, a follow-up study is recommended before any alterations to selection and teaching methods are indicated or any definitive statements about the influence of age and gender on adjustive skill are made.

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