AN EVALUATION OF THE MENTAL SKILLS, NUTRITIONAL PREFERENCES AND ANTHROPOMETRIC CHARACTERISTICS OF THE PRO JUNIOR UNDER 20 SURFERS IN THE 2008 BILLABONG JUNIOR SURF SERIES IN SOUTH AFRICA.

by

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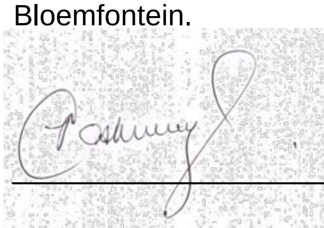
DECLARATION

I, Frederick P Oosthuizen, hereby declare that the work on which this dissertation is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work or any part of it has been, is being, or has to be submitted for another degree in this or any other University.

It is being submitted for the degree of Masters of Sport Medicine in the School of Medicine in the Faculty of Health Sciences of the University of the Free State, Bloemfontein.



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ABSTRACT

Shortboard surfing continues to increase in popularity. In South Africa, surfing is not yet truly a profession. Successful u/20 surfers are rewarded with lucrative sponsorships, prize money and selection for national surf teams. For many competitive u/20 surfers, their ultimate goal is to qualify for the lucrative World Qualifying Series (WQS) and World Championship Tour (WCT).

The competitive junior surfer and his support team (family, coach, and sponsors) invest a lot of time, commitment and money in striving for success. Whilst the u/20 surfer strives for quality water time in all conditions, he will benefit should his support staff be well informed about mental skills and nutrition. The aim of this research was to identify variables which can influence the surfer's ability to perform consistently at a higher level of competition.

Past research in surfing has shown that, although smaller in stature than other elite sportsmen, physical traits in surfing are less important than mental skills and correct nutrition.

107 Surfers entered in the 2008 Billabong Junior Series of 5 contests around South Africa. 41 Of these surfers participated in this research. Their anthropometric variables namely height, mass, body density, body mass index and % fat were recorded. Waist to hip, chest to waist and chest to hip ratios were measured. The Ottawa Mental Skills Assessment Tool was used to assess mental skills and a 24 hour dietary recall questionnaire was completed.

The main findings were that with a shorter stature, the surfers chose a sport which suited their physique best. The mental skills of commitment self-confidence and goal setting scored high, but stress reactions and refocusing skills were poor. At the contest venues, the food and fluid available determined their diet. They had no definite pre heat, inter heat or post heat eating plans.

We concluded that mental skills and correct nutrition are two factors which a competitive surfer can utilize to improve their surfing performance. We recommend that

a 12 variable progressive forward discriminant analysis be applied to talent identification in surfing, as also to identify and to improve necessary skills which are lacking in the competitive u/20 surfer.

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LIST OF ABBREVIATIONS

ABF	Absolute Body Fat
ACSM	American College of Sports Medicine
ANOVA	Analysis of Variance
ASP	Association of Surfing Professionals
BM	Body Mass
BMI	Body Mass Index
CHR	Chest to Hip Ratio
CWR	Chest to Waist Ratio
DEXA	Dual Energy X-Ray Absorptiometry
EER	Energy Expenditure Rate
g	Grams
GI	Glycemic Index
IOC	International Olympic Committee
ISA	International Surfing Association
Kcal	Kilocals
Kg	Kilograms
KJ	Kilojoules
LBM	Lean Body Mass
M	Meters
MJ	Megajoules
OMSAT	Ottawa Mental Skills Assessment Tool
PAL	Physical Activity Level
PSIS	Psychological Skills Inventory for Sports
PST	Pro Surf Tour
RBF	Relative Body Fat
RMR	Resting Metabolic Rate
SAIDS	South African Institute for Drug Free Sport
SD	Standard deviation
SSA	Surfing South Africa
TOPS	Test of Performance Strategies

VO_2(max)	Maximal Oxygen Uptake
WCT	World Championship Tour
WHR	Waist to Hip Ratio
YR	Years

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CHAPTER 1

Introduction and scope of the study

1.1 INTRODUCTION

The Billabong Junior Series is an annual short board surfing competition, held at different venues throughout South Africa. During 2008, the twelfth year of this junior series, five contests were held between February and September. Surfing South Africa (SSA) co-ordinates all aspects of surfing in South Africa. Surfing South Africa's aim is to make the sport accessible to all and to remain a significant force in international surfing. Surfing South Africa will achieve this through the ongoing development and implementation of structured programs while ensuring the transformation of sport at all levels (Mission Statement of Surfing South Africa). Felder et al., 1998 reported that anthropometric analyses of surfers have revealed that a surfer's body composition does not play a major role in surfing performance. To enable SSA to achieve these aims potential elite surfers need to be identified, and then they should be afforded well informed support from their support team.

SSA is a member of the International Surfing Association (ISA), which is recognized by the International Olympic Committee (IOC) as the world governing authority for body-boarding and surf-riding. When competitive surfers excel at National and International competitions, they may be invited to qualify for the professional international surfing circuit, which is governed by the Association of Surfing Professionals (ASP). There are eleven Pro Tour Events each year on the international surfing calendar, with the surfer scoring the highest during the year being crowned World Champion.

The judges score each wave that the surfer rides during the heats. Heats are normally 20 minutes, except for the Finals heats, which can be 30 minutes. Regardless of how many waves surfers ride during their heat, only their two highest scoring rides count in the final tally that decides the eventual heat winner. Judges allocate points for each wave ridden according to the ASP judging criteria.

Surfers must perform to the ASP Judging Key Elements to maximize their scoring potential. Judges analyze the following major elements when scoring a wave ridden:

- Commitment and degree of difficulty
- Innovative and progressive maneuvers
- Combination of major maneuvers
- Variety of maneuvers
- Speed, power and flow

It is important to note that the emphasis on certain elements is contingent upon the venue and the conditions on the day, as well as changes of conditions during the day (Association of Surfing Professionals Rule Book).

Competitive surfers, their parents, coaches and sponsors show large commitment to achieving success. Children and adolescents are becoming increasingly involved in competitive sport, and, as a consequence, are engaging in specialized training with the objective of enhancing their sporting performance (Barker and Armstrong, 2011). The competitive surfers, their families and support staff invest a lot of time and money in an attempt to reach the top in competitions. Due to major time commitments, a number of the top achievers in the Billabong Junior Series spend their year surfing at venues away from home and school, necessitating home schooling. Those surfers finishing this premier competition for u/20 surfers in South Africa in higher positions can expect lucrative sponsorships and selection for National age group teams as well as striving for the ultimate goal -to participate internationally on the World Championship Tour (WCT). The WCT events have 36 surfers competing in each of the 11 events per year. Expectations and pressures placed on these young surfers can be more destructive than constructive. The Pro Surf Tour (PST) in South Africa now consists of 3 events, with a first prize of R10000.00 per event.

To progress to international level of surfing, the u/20 competitive surfers will require well informed support from their support team. Whilst the surfer strives for maximum water time in all conditions, the support team (parents, coaches and sponsors) need to be informed about correct nutrition, and the mental skills needed by the surfer to cope with the pressures of competition. Coaches have to be able to identify potential champions, and then to nurture their skills, both physical and mental. Sponsors must be assisted in identifying true surfing potential. Identifying characteristics which separate elite surfers from competitive surfers can be of assistance to the surfers and their coaching team.

This will result in better and more consistent performances, both in training and competition. Brukner and Khan, 2007 describe the psychological wellbeing of the athlete to be important in decreasing the drop-out rate. Fewer injuries will result in longer careers. The surfer with natural ability can be assisted to develop into an elite performer, provided the surfer has enough ambition to succeed. Areas resulting in stress and impairing the ability to perform at a higher level must be identified. Nothing is more common than talent without success (Weinberg and Gould, 2007). The young athletes need appropriate and ongoing physiological assessment and support (Barker and Armstrong, 2011) to meet the holistic requirement of these young athletes to achieve success.

The purpose of this study is to assess the physical traits, mental skills and nutritional preferences of the participating surfers. Characteristics that could possibly discriminate between elite and competitive surfers may be identified, and be conveyed to the coaching team and surfer. It is an exploratory study of the factors that may affect the success of surfers. Mendez-Villanueva et al., (2010), in a study of eleven WCT competitions concludes that competition outcomes are largely unpredictable. Surfers showed much larger variability in performances than previously reported for sports such as running, swimming or weightlifting (Mendez–Villanueva et al., 2010). Mick Fanning, World Surfing Champion in 2007 and 2009, attributes his success to years of preparation, correct nutrition and mental focus. In contrast, a lack of nutrition, psychological preparation and recovery may increase the risk of drug taking and doping (Brukner and Khan, 2007).

The study will test certain of the following findings in previous research conducted with elite surfers.

1.2 ANTHROPOMETRIC ASSESSMENTS

Elite surfers display specific size attributes, having a lower height and body mass when compared with other matched aquatic athletes (Mendez-Villanueva and Bishop, 2005). Surfers have an increased body fat compared with other level matched athletes. Barlow et al., 2012 in a study of 15 junior national surfers reports a correlation between the rating of surfer ability with endomorphy, mesomorphy, sum of 6 skin folds and body fat %

1.3 MENTAL SKILLS

Self-confidence, commitment and goal setting are the best discriminating mental scales between elite and less competitive athletes (Bota, 1993). Focusing is added as an important fourth mental skill. Thomen (2009) regards the mental environment as being far more important than the physical traits of the surfer. Pure talent can only take the surfer so far. It is what you do with that talent which decides whether the surfer develops into an elite performer. Talent is a genetic ability you are born with. What the surfer does with that ability depends on himself (Collins, 2009).

1.4 NUTRITION

During surfing competitions, carbohydrate and confectionery intake was significantly higher than protein intake (Felder et al., 1998).

CHAPTER 2
Literature review

2.1 INTRODUCTION

Surfing is a balance reliant, open skill performed in a dynamic environment rich in visual, somatosensory and vestibular information (Chapman et al., 2008). Surfing requires skill, balance, co-ordination, accurate timing, and an ability to read the waves, core strength, flexibility and mental skills (Collins, 2009).
Additional factors affecting performance are nutrition, sleep and rest, training, skills, mental attitude and the equipment. To be successful, surfers need skills (raw talent) and enough ambition. Skill can be nurtured. This must be combined with sufficient time in training, the right equipment and correct technique training. The surfer should focus on factors he/she can control.

Elite performers design their lives around the maximizing of training, thus justifying a high level of commitment (Ericson et al., 1993). Surfing is a sport requiring exceptional whole body physical skills, technique and mental attitudes. Physical fitness and genetic ability alone cannot compensate for the full development of these attributes (Mendez – Villaneuva and Bishop, 2005). To take a surfer with natural ability and develop him into an elite performer, non genetic environmental influences must be considered. To enhance performance and to perform consistently at a higher level, training and preparation for competition should include mental skills, sound nutrition and physical training. Surfing is a sport really changing in its professionalism (Carton, 2007). It is necessary for surfers to adopt a more professional approach to their competitive preparation to maximize performance and minimize injuries. During the 2011 ASP World Tour Events up to 07 November, seven of the top forty ranked surfers missed one or more of the 11 contests due to injury, with four surfers missing two or more events due to injury (ASP World Tour). Nathanson et al., (2007) reported an injury rate in surfing of 5.7/ 1000 athlete exposures, or 13/ 1000 hours of competitive surfing.

2.2 ANTHROPOMETRY IN SURFING

Meltzer and Fuller (2008), whilst stating that the athlete should chose a sport which suits their natural physique best, recognize that genetics is a major determinant of body fat and body shape. With diet and training, body shape can be remolded. With surfing, the possibility of an ideal Body Mass Index for balance may exist. The Centers for Disease Control and Prevention utilize a BMI for age growth chart, as also a stature for age and weight for age chart.

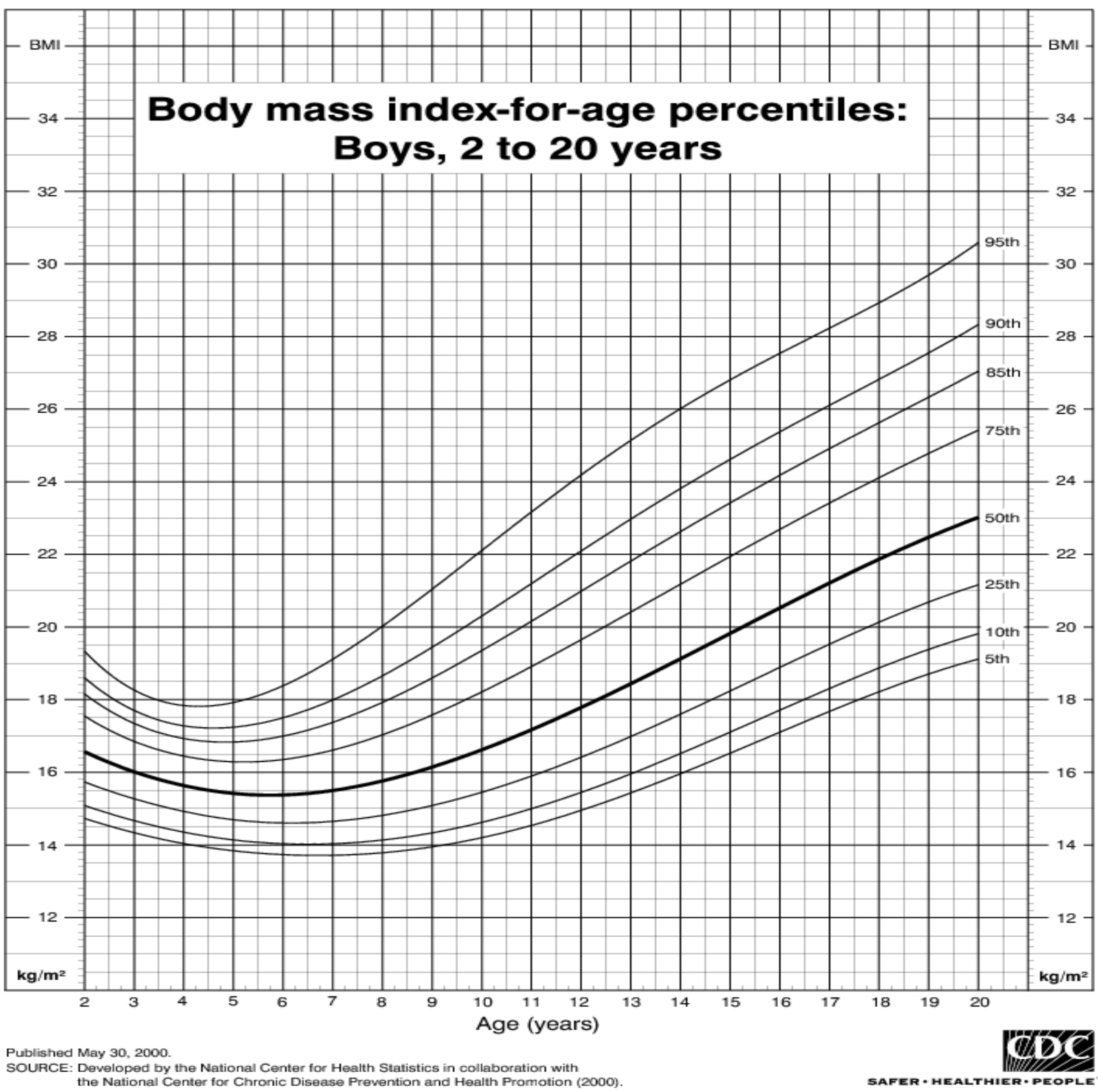


Figure 2.2.1 Body Mass Index-for-age percentiles in boys aged 2 – 20 years

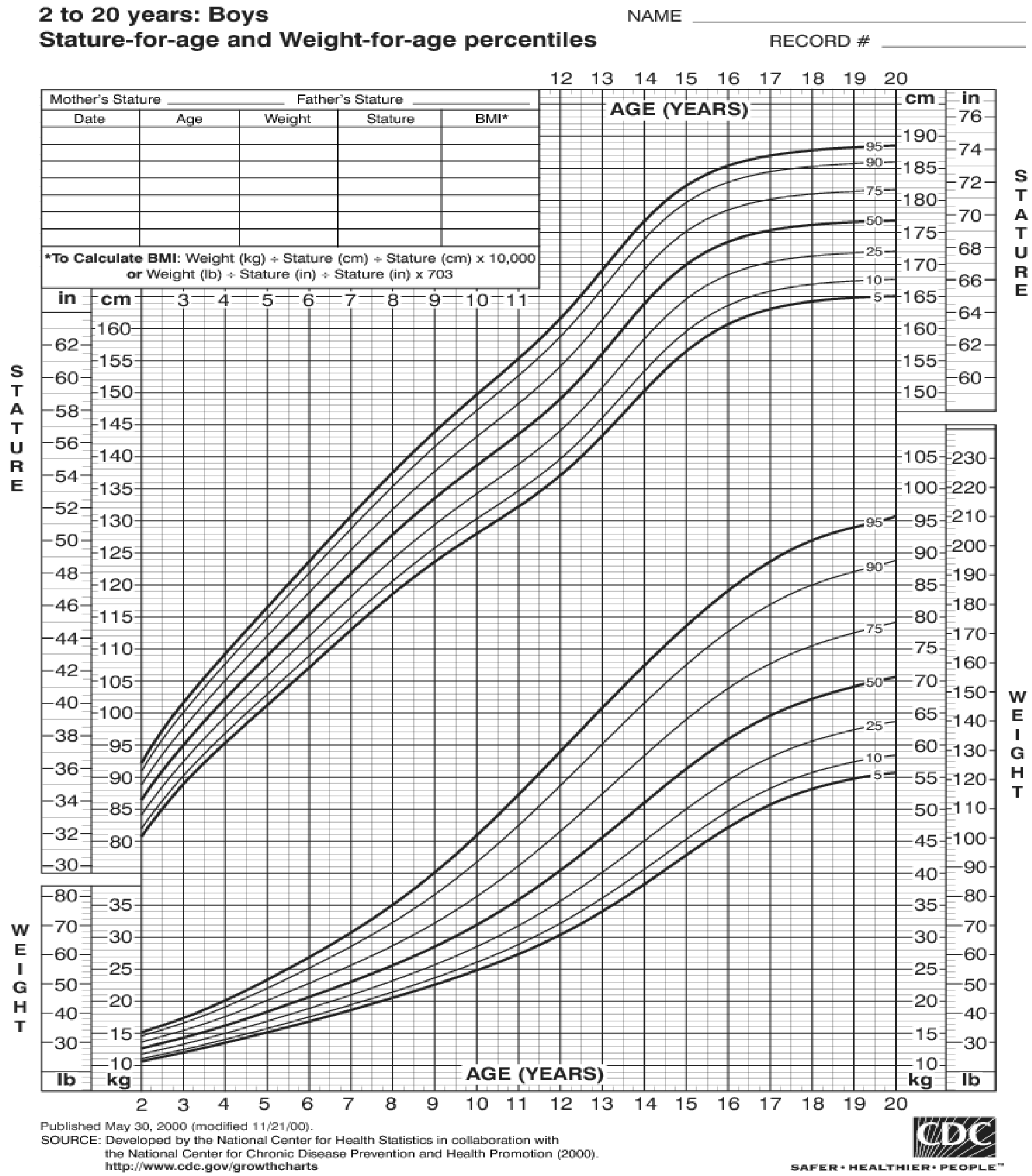


Figure 2.2.2 Stature-for-age and weight-for-age percentiles in boys 2 – 20

Low body fat is an advantage in most sports and fitness activities. Although there is no reported ideal body fat related to surfing, it is possible that increased body fat in surfing will provide protection against the constantly wet and sometimes windy surfing environment (Lowdon and Pateman, 1980). Previously it was postulated that aquatic sports people tended to have a higher percentage body fat, enabling them to have better buoyancy, as well as to prevent hypothermia (Meltzer and Fuller 2008). Moreover, the surfer with low body fat levels may experience susceptibility to early fatigue, intolerance to cold and increased risk of infection. This could result in a loss of skills and concentration (Meltzer and Fuller, 2008). Fat distribution can be estimated by using the ratio of waist circumference to hip circumference.

When skinfold measurement are used to determine % body fat, the prediction equations used to predict the % body fat need to be population specific in terms of gender, race, age and activity level (Davies and Cole, 1995). The Siri equation (1956) is for use in Caucasians. Skinfold method is based on two assumptions - that there is a relationship between total body fat and subcutaneous fat, as also that skinfold measurement can accurately measure subcutaneous fat. Skinfold measurement is susceptible to many sources of error. The sites need to be exactly located, only subcutaneous fat must be measured and sufficient time must be given between measurements as the calipers compress the fatty tissue. The measurements are also dependent on the skill and background of the technician performing the measurements (Heyward and Stolarczyk, 1996). Although there are more accurate methods of determining body composition, such as underwater weighing, air displacement (BOD POD) and dual energy x ray absorptiometry (Dexa), the measurement of skinfolds remains one of the most widely used techniques for estimating body composition.

Competitive surfers were found to be shorter and lighter than the average age matched sporting population (Mendez-Villanueva et al., 2005). In 2003, in a study of 44 surfers, with an average age of 27.5 ± 3.6 yr, the average height was 174.7 ± 6.1 cm. Elite swimmers and water-polo players were found to have a greater height- 183.8 ± 7.1 cm in swimmers, and 186.5 ± 6.5 cm in water-polo players. Lowden and Patemen (1980), in a study of 76 international male surfers, found an average height 173.6 ± 5.9 cm and an average body mass of 67.9 ± 7.2 kg. Loveless and Minahan et al., (2010) assessed maximal paddling performance in surfboard rides in 11 male surfers. Their average age was 17 ± 1 yr, average body mass 61.1 ± 9.2 kg and average stature 1.71 ± 0.08 m. This was lighter than in elite swimmers and water-polo players. It is possible that relatively short and light body type may be advantageous for performing specific movements in surfing. Hayes, (1982) found stability is inversely proportional to the height of the center of gravity above the base of support. Therefore a lower center of gravity would allow surfers to obtain better dynamic balance performances, which would appear to be crucial in surfing. Chapman et al., (2008) found possible systematic differences in balance abilities between expert surfers and controls.

Elite surfers display specific size attributes, particularly a mesomorphic somatotype (Mendez-Villanueva and Bishop, 2005). Somatotyping is one of several techniques to evaluate human body morphology. Lowden and Pateman (1980) in a study of 76 male and 14 female international competitive surfboard riders reported that world class surfboard riders possessed a distinctive somatotype, showing the following mean values for men and women respectively;

Endomorphy (fatness)	:	men 2.6	women 3.9
Mesomorphy (muscularity)	:	men 5.2	women 4.1
Ectomorphy (linearity)	:	men 2.6	women 2.6

Mendez-Villaneuva et al., (2005) found that peak power output is stastistically greater in elite surfers than in regional and competitive surfers. Rank was inversely correlated with peak power output. Better surfers have higher upper body aerobic fitness scores (Mendez-Villanueva and Bishop, 2005). This suggests specific upper body physiological attributes may be important for competitive surfing performance. They found differences in some physiological profiles may reflect a superior genetic endowment, or simply that better surfers are exposed to more demanding workloads despite a similar volume of time on the water. Mendes-Villanueva et al., (2005) found peak power output (W Peak), tested in thirteen male surfers performing an incremental dry-land board paddling test, was the most strongly correlated with performance ranking. No significant difference in VO_2(max) values between surfers of different competitive levels was found. Power to body mass ratio is an important determinant of performance (Meltzer and Fuller, 2008). Brute muscle power is not paramount in surfing (Collins, 2009). The ratio of muscle to fat enables the maximizing of force output.

Surfing places demands on the upper body (paddling) and lower body (wave riding). Carton (2007) lists the primal patterns for the sport of surfing as: the lunge pattern, the twist pattern and the pull pattern (paddling). It is possible that fatigue induced at a site remote from the legs (as with paddling) might be associated with some negative effects on postural control and performance during wave riding (Mendez-Villanueva et al., 2006). Olmeda et al., (2009) in a study of 40 male sport science students, recommended that surfers improve their paddling capacity in order to avoid or delay fatigue during wave riding.

Palliard et al., (2010) report that expert surfers could shift the sensorimotor dominance from vision to proprioception for postural maintenance. A relationship between the postural ability and the competitive level of surfers has also been determined. They conclude postural ability reflects the athletic skills of the competitive surfer. Chapman et al., (2008) report concurrent mental task findings illustrate that systematic differences in balance abilities between expert surfers and controls may exist. Control of balance is complex and involves maintaining postures, facilitating movement and recovering equilibrium. Balance control consists of controlling the body center of mass over its limits of stability (Mancini and Horak, 2010). Balance is achieved by the complex integration and coordination of multiple body systems, including the vestibular, visual, auditory, motor and higher level pre-motor systems (Mancini and Horak 2010). To maintain balance encompasses the acts of maintaining, achieving or restoring the body center of mass relative to the base of support (the surfboard).

From informal discussions and media interviews with u/20 surfers and 2011 Jeffreys Bay WCT surfers, the researcher observed that both elite and competitive surfers have adopted the attitude that they do not need to train. This impression could be due to the stop start nature of surfing resulting in a low work to rest ratio. This observation has been substantiated by time motion analysis which demonstrated that surfing is an intermittent sport. Mendes-Villanueva et al., (2006) analysed the activity profile of 42 male surfers during 42 elimination heats in a competition. Arm paddling represented approximately 51% of the time. The surfers were stationary 42% of the time, whilst wave riding accounted for 4-5% of total time when surfing. The remaining time was taken up with miscellaneous activities (duck-diving, climbing back onto the surf-board or running along the shore). The duration of most paddling bouts were 1-20 seconds. In a similar study on recreational surfers, Meir et al., (1991) found similar activity profiles in the 4 distinct activity categories: paddling 44%, stationary 35%, wave riding 5% with the rest miscellaneous activities. Mendez-Villanueva and Bishop, (2005) found a work to rest ratio of 1:1.25 in elite surfing. These results show surfing is an intermittent activity characterized by a large variability and random distribution of paddling, wave-riding, stationary and miscellaneous activities (Mendez-Villanueva et al., 2006). Sheppard et al., (2012) demonstrated a strong association between relative upper body pulling strength and sprint paddling ability in surfers. Therefore there is a need to emphasize upper body strength

2.3 MENTAL SKILLS IN SURFERS

Competitive surfing requires great mental and cognitive activity in a wide range of environmental conditions (Mendez–Villanueva and Bishop, 2005). Athletes may train optimally, but if they display certain mental inadequacies or they have not acquired certain mental coping skills to deal with themselves, competitive and other stressors, they are unlikely to perform to their full potential (Carton, 2007). In pressure situations, mental skills will elevate the ordinary athlete into the realm of the extraordinary (Weinberg and Gould, 2007). Cognitive behavior therapy increases motivation, confidence and overall physical performance. Mental skills training should be the foundation of each athlete's individual training regimen (Weinberg and Gould, 2007).

Several authors report a definite association between certain mental skills and the enhancement and maintenance of high level sport performance. Orlick and Partington (1998) and Orlick (1998) noted that important elements of success reported by successful international athletes were:

- total commitment
- quality mental preparation that included daily goal setting and imagery training
- quality mental preparation for competition that entailed developing a pre competition plan, competition focusing and refocusing plans, as well as post competition evaluation plans
- belief
- self-confidence

Bota, (1993) reported that self-confidence, commitment and goal setting were important mental skills. Goal setting was one of the best discriminatory scales between elite and less competitive athletes. Durand-Bush et al., (2001) found goal setting, commitment and self-confidence were associated with enhancement and maintenance of high level sport performance. Nideffe and Segal, (2001) showed concentration is often the deciding factor in athletic competitions. Athletes were asked to identify and rank the 4 mental skills that they perceived as most important or useful. They identified: goal setting, self- confidence, commitment and focusing (Durand-Bush et al., 2001). The Ottawa Mental Skills Assessment Tool (OMSAT) 3 study validity testing showed that self confidence, commitment, stress reaction, focusing and refocusing were most important in discriminating between elite and less elite athletes.

On the other hand, excessive psychological arousal does not only impair sporting performance, it is also likely to increase the risk of injury (Handford et al., 1997). Over arousal is associated with the impairment of natural technique, which athletes describe as a loss of rhythm (Brukner and Khan, 2007). Loss of concentration (focus) can also predispose to injury by giving the athlete less time to react to certain cues. When discussing the benefits of tapering before a big competition, Everline, (2007) recommends that during the tapering phase focus must be concentrated on regeneration, recovery and mental preparation.

OMSAT 3 is used as an instrument to measure the mastering of a broad range of mental skills (Salmela, 1992). It is suitable for this research because the original study involved 335 participants from 35 different sporting codes. Included in the OMSAT study were 37 water-polo players, 33 swimmers, 23 baseball players, 39 soccer players, 56 hockey players and 34 basketball players. The average age of the athletes involved in the original study was 19.6 years. Using a Likert Scale (strongly disagree to strongly agree), OMSAT 3 comprises of 48 questions or items. More specifically, there are 4 items for each of 12 mental skill scales. The 12 mental skills are grouped under 3 broader conceptual components:

- foundation skills – goal setting, self confidence and commitment
- psychosomatic skills- stress reactions, fear control, relaxation and activation
- cognitive skills - focusing, refocusing, imagery, mental practice and competition planning.

The seven points Likert scale allows the surfer to answer a question from strongly disagree through do not agree/disagree to strongly agree.

The aim of the psychological assessment was to generate a typology of the mental skills profile of the successful U/20 surfers. This will enable the surfer to be moulded with psychological skills training. As a result, the competitive surfer will theoretically be able to cope with anger and frustration due to a disappointing performance. Strategies can be taught to avoid “choking” when behind, as also to prevent loss of focus during a contest. As with most young athletes, surfers must be trained to cope with injuries, development issues and the particular lifestyle of competitive sport. Stress management and education of the parents are additional needs. Skills taught are for a lifetime.

Two alternative mental skills assessment tools were also considered as measuring tool. The Psychological Skills Inventory for Sports (PSIS) (Mahoney et al., 1987) test has 45 items, in a true / false format. A five point Likert scale is used. The PSIS assesses anxiety control, motivation, mental preparation, concentration, confidence and team orientation. However, the PSIS is still awaiting formal and extensive psychometric evaluation, and the underlying structure of the six factors it measures has been questioned.

The Test of Performance Strategies (TOPS) mental test (Thomas et al., 1999) has a 64 item inventory, and measures factors in both the competitive situation and the practice situation. Factors in the competitive situation include self talk, emotional control, automaticity, goal setting, imagery, activation (mentally psyching oneself up), negative thinking and relaxation. Factors measured by TOPS in the practice situation include the same factors used in the competitive situation, with the exception that negative thinking is replaced by attentional control. Thirty two of the 64 items in TOPS are related to the competitive situation. The remaining thirty two items are related to the practice situation. Hardy et al., (2010) Identified poor fits during analysis of the competition and practice subscales of TOPS. In their study they address the problems identified and created TOPS 2.

2.4 NUTRITION IN SURFING

Very little is known about the energy needs of young athletes (Thompson and June, 1998). The dietary needs and challenges of adolescents differ from those of adults (Melzer and Fuller, 2008). Their diet must provide adequate energy and nutrients to support normal growth. Potential consequences of inadequate energy and nutrient intakes in young athletes include poor health, fatigue, and limited recovery from injuries and poor performance. Nutritional needs for peak athletic performance include sufficient caloric intake, adequate hydration and attention to the timing of meals. The benefits of sound nutritional practices for performance and health should be an essential part of the education of surfers, coaches and in particular the parents of young surfers (Williams and Seratose, 2006). Melzer and Fuller, (2008), when discussing sports nutrition, place surfing under aesthetic considerations whereby the training load is focused on skill and technique rather than energy consuming aerobic exercise. As a result, the energy demands of surfing training will not always tax the full energy reserves. There must be differentiated between in and out of contest eating strategies. It is noted that 90% of female surfers do not have good nutritional habits when traveling, which is compounded by a lack of knowledge of nutritional practices (Felder et al., 1998). Self-report dietary records of young athletes indicate that energy, carbohydrate and select micronutrient intake of certain athletic groups and individual athletes may be marginal or inadequate (Thompson and June, 1998).

Surfing is a unique sport in that competitions are held at beaches, often in remote places. Often surfing locations have no permanent catering facilities, and when food is prepared it may be of questionable nutritional value. Surfers have highly variable eating behaviors surrounding competition (Felder et al., 1998). They may eat more than normal to enhance glycogen stores, or eat less due to anxiety or gastro-intestinal upsets. Inadequate nutrition can predispose to overtraining syndrome and may play a role in the development of musculoskeletal injuries (Brukner and Khan, 2007). The dietary history of the surfers is important to identify their likes and dislikes, consider availability and to enhance recovery by implementing post competition programs. Nutrition has a practical role to play in advising on strategies to overcome problems such as the limited time and facilities available for food preparation, travel nutrition and loss of appetite before a competition. The energy demands of surfing must be met, taking into consideration that surfers cannot ingest carbohydrate during contest heats (Meltzer and Fuller, 2008).

To advise on nutrition in surfing, the energy demands of the sport must be known. In addition, the nutritional content and functions of certain foods, sport supplements and fluid must be known (www.foodfinder.ac.za). Then only can the diet be manipulated to improve endurance, aid recovery, alter body composition (muscle to fat ratio), reduce fatigue and improve mental performance and skills (Meltzer and Fuller, 2008). Energy expenditure within a sport can either be measured in a laboratory, or estimated using prediction equations. Within the laboratory, indirect calorimetry or doubly labeled water may be used. With indirect calorimetry, the surfers would be confined to the laboratory. Doubly labeled water, using deuterium and oxygen isotopes can measure energy expenditure in free living subjects for 3 days to 3 weeks. This method only requires periodic collection of urine for measurement of the isotope elimination rates, but it is expensive. Recently accelerometers have become available to predict expenditure. Frequency, intensity and duration measures of activity are recorded and stored for weeks at a time. However, Esliger and Tremblay, (2006) report accelerometers designed to measure the same thing, namely activity and energy expenditure behave so differently.

When assessing total energy expenditure without laboratory facilities, it can be estimated by applying prediction equations to estimate resting metabolic rate (RMR), then multiplying RMR by an appropriate activity factor. Prediction equations have been developed for different populations that vary in age, gender, level of obesity and activity levels. Thompson and Manor, (1996) found that for both active males and females, the Cunningham Equation (1980) best predicted RMR in this population. RMR (Kcals/day)=500+22 (LBM). LBM is the lean body mass. To assess total daily expenditure, Thompson and Manore, (1996) multiplied RMR by an appropriate activity factor. The Physical Activity Level (PAL) for surfers would vary between moderate activities (PAL 1.8) to heavy activity (PAL 2.1). The ACSM guidelines on General Physical Activities, categorized by intensity level, lists surfing as a moderate activity, which burns 3.5 – 7.0 Kcal per minute.

To estimate Lean Body Mass (LBM), the equation is Body Mass (Kg) - Absolute Body Fat (Kg): LBM (Kg) = BM (Kg) –ABF (Kg)

To estimate Absolute Body Fat (ABF), the relative body fat (RBF) % is multiplied by the body mass in Kg, then divided by 100: ABF = RBF (%) x body mass ÷100

An alternative equation to predict total daily energy expenditure is the published equation of Food and Nutrition Board of the Institute of Medicine (2000). This equation is for adult males, and not tested for adolescents. In adult males, EER = 660 - (9.53 x age) + PAL x (15.91 x mass + 539.6 x height). The PAL value to be used for surfing is 1.8.

Felder et al., (1998) estimate the typical energy cost per day for surf training and competition to be 10 MJ. Surfing must be approached as a multi-event competition when assessing nutritional requirements. Surfers give nutritional practices less attention than practicing and experimenting with equipment (Felder et al., 1998). By assessing the likes and dislikes of these surfers, the aim should be to offer sound nutritional practices as an alternative to performance foods (ergogenic aids). The downside of food diaries is that they take time and commitment to be completed well. The increased time and burden of food diaries on the surfers during the competitive phase is likely to be unacceptable. The major challenge for dietary studies is accuracy of reported dietary intake (Lundy, 2006). Most studies reporting the dietary intake of athletes have not examined the data with respect to under and over reporting.

High Glycemic Index (GI) foods - a value of 70 or greater - enable liver and muscle glycogen stores to be replenished. These foods are important in post contest heat and recovery meals. Examples of high GI foods are sports bars, sports drinks, cereals, muffins, toast, pancakes, sandwiches, rolls, pastas (wheat), fruit smoothies, fruit salad and liquid meal supplements. Low GI foods – a value of 55 or below- provide a sustained energy release that may help endurance performances. They are important in pre-contest meals and result in feelings of satiety for longer and produce a more stable blood glucose concentration than after a high GI meal (Erith et al., 2006) (Williams and Seratose, 2006). Examples of low GI meals are baked beans, pasta (durum wheat and fine form), oats and most fruits (Meltzer and Fuller, 2008). An attempt should be made to delay the appearance of fatigue that might diminish the ltechnical standard and cognitive function of the surfer during a contest heat. Increasing fatigue results in loss of skill and concentration. Carbohydrate requirements should be individualized to meet energy and activity levels. Carbohydrate loading is not necessary in surfing. Individualizing an athlete's meal plan should consider the following 4 factors:

- food preferences of the athlete
- digestibility of foods
- psychological stress of competition anxiety, which may result in a loss of appetite.
- availability of foods and fluids

High fat meals or snacks slow down the rate of gastric emptying and are not recommended just before training or competing. Hidden fats are chocolates, crisps and nuts. Protein is not an efficient source of fuel during exercise, but aids recovery especially with muscle or tissue damage (Felder et al., 1998). Muscle damage also interferes with the storage of carbohydrate as glycogen. Therefore the recovery meal must include extra carbohydrate with the protein. The aim of the recovery meal is to replenish liver and muscle glycogen stores, replace fluids and electrolytes lost and to regenerate and repair damaged tissue. Vegetable sources of protein are low biological value since they do not provide the full range of essential amino acids, the building blocks of protein.

Dehydration in sport can affect performance. Therefore any exercise session should be started well hydrated to minimize fluid deficit. Water alone is not the best means of restoring body fluids, since carbohydrate electrolyte drinks display better intestinal absorption and reduce urine output (Brukner and Khan, 2007).

CHAPTER 3
Methodology

3.1 STUDY DESIGN

The study was descriptive and analytical. Specific anthropometric characteristics, mental skills and nutritional preferences of the u/ 20 surfers participating in the Open division of the 2008 Billabong Series were analysed to determine whether there is a relationship between certain variables and success in the Billabong series.

3.2 PARTICIPANTS

The participants were selected from males entering into the Open division of the Billabong 2008 series. Participants were injury free, and were enrolled at each of the five contest venues along the South African coastline. The competing surfers were informed of the research project via personal approaches by the research team, as also via the public address systems at the contest venues. Notices explaining the research project were posted on the bulletin boards at the venues. The average age of the participants was 16 years 3 months. The number of surfers contesting the u/20 Billabong series in 2008 at the five different venues remained constant. The first contest attracted 55 entries (St. Mikes), with the subsequent contests attracting 57 surfers (Durban), 56 surfers (Cape Town), 58 surfers (Victoria Bay) and 64 surfers (Jeffreys Bay). A total of 107 surfers competed in the 2008 Series. Forty-one surfers participated in the research. Twenty seven of the surfers completing the contest season in the top 30 rankings participated in the research.
A convenient sampling technique was utilized. This sample is representative of the top u/20 surfers.

3. 3 ETHICS

The research proposal was accepted by the Ethics Committee (ECUVS no. 195/07) of the University of the Free State. Informed consent was obtained after explaining the study and methods. All information remained confidential, and the identity of the participants was protected. Surfers under 18 years of age were required to sign assent as well as consent. Consent was obtained from the organizers, Billabong South Africa. The names, telephone numbers and e-mail addresses of the participants were taken, in order to inform them of their personal results and the overall study results. Participants not participating in the research were reassured that they would not be discriminated against. The participants were given the name and number of a contact person in the research team.

3.4 PILOT STUDY

A pilot study was conducted on eight high school recreational surfers, aged 15 to 18 years in Jeffreys Bay. The 24 hour dietary recall questionnaire was assessed, as also the OMSAT mental skills questionnaire. The research team conducted the necessary anthropometric measurements. The data was analyzed.

3.5 DATA COLLECTION

The training of the research team involved in data collection included explaining the nature of the research, the reason why the research was being done and the objectives of the study. A dietician interviewed each participant individually when completing a 24 hour dietary recall. A sports scientist conducted the physical measurements, whilst a medical practitioner supervised the psychological questionnaire. The questions were conducted in the language of choice- either English or Afrikaans. The researchers remained the same for all of the five contests.

The sports scientist conducted the physical measurements, according to ACSM guidelines (2006). Body mass was measured on a standardized digital scale, with the surfer wearing swim shorts. The body mass was measured at the time of the interview and examination and not specifically pre or post contest heat. The scale was placed on a wood surface at each venue. Height was measured with a standard metric tape measure, with the surfer standing against a wall without footwear. An inelastic metric tape was used to measure chest, waist and hip circumference. The chest measurements were taken midway between full inspiration and full expiration – the resting phase of respiration. The waist was measured at the narrowest part of the abdomen, above the umbilicus and below the xiphoid process. The hip measurement was taken with the surfer standing, legs slightly apart. A horizontal measurement was taken at the maximal circumference of the hip, just below the gluteal fold. Skinfolds were measured according to ACSM (2006) guidelines. Seven sites were recorded, with all measurements made on the right hand side of the body, with the surfer standing upright. Duplicate measurements were taken at each skinfold site and retesting done if duplicate measurements were not within 1-2 mm of each other. The Seven Site Formula for men was used to determine the body density.

Variation and bias were limited by limiting the number of observers, training them, calibrating and standardizing the measurement procedure and instruments. Periodic checking ensured measurements were still being done correctly. The Body Mass Index for each surfer in the study was calculated as the weight in kilograms divided by the height in meters squared (kg/m^2). The Body Density was estimated using the seven site formula (Jackson and Pollock,1985) based on the seven skinfold measurements as follows: 1.112-0.00043499 times the sum of the seven skinfold measurements + 0.00000055 times the sum of the seven skinfold measurements squared-0.00028826 times age. The percentage body fat was calculated for each surfer in the study using the Siri formulae: 4.95 divided by the body density-4.50 all times 100.

The mental skills assessment utilized the OMSAT 3 Mental skills questionnaire. The medical practitioner in the research team assisted each surfer where necessary with the completion of the 48 item questionnaire. The answers were presented on a Likert scale, ranging from strongly disagrees to strongly agree. The questionnaire was submitted online to MindEval (Fournier et al., 2005), an internet based software program for assessing the mental skills test results. When explaining the questions where necessary, prompting was avoided.

The nutritional interview consisted of a 24 hour recall of food and liquids ingested. In addition, food and fluid preferences and dislikes were noted. Any supplement use was documented. A 24 hour dietary recall check list was utilized. This check list took into account the foods available at the venues.

3.6 DATA ANALYSIS

The data was captured in Microsoft Excel and imported into Statistica (StatSoft, Inc. 2011) to conduct a statistical analysis of these data. Histograms and boxplots were used to graphically display the distribution of the variables of interest. The descriptive statistics calculated for these variables are the number of observations, denoted by `n', the mean or average and associated confidence interval for the mean and the standard deviation for each variable. These are reported in tables in the various sections.

Two-sample T-Tests were applied to compare whether the average difference between the two groups (top twelve vs the rest) is really significant or if it is due instead to random chance.

The one-way analysis of variance (one way ANOVA) technique was used to test for significant differences in the mean (or median in the non-parametric case) values if more than two populations were being considered. Levene's test was used to assess the homogeneity of variances that is the equality of the variances in the relevant populations. Scheffe's post hoc test was used to test which population means was significantly different if the one way ANOVA indicated that the population means were significantly different. If the variances were found to be unequal the Kruskall-Wallis ANOVA, an equivalent non-parametric technique, was used instead of the one-way ANOVA. Linear regression was used to test if there was a significant linear relationship between a surfer's performance and the various independent variables. Finally a forward stepwise discriminant analysis was used to determine if the top twelve surfers could be separated from the rest of the surfers in this study and if so based on which variables of interest. This was an attempt to predict the possible rankings (top 12 or not) of the u/20 surfers based on certain measurable variables.

3.6.1 Anthropometric measurements

These measurements were plotted against variables such as age and final rankings at the end of the Billabong Series 2008.

3.6.2 Mental Skills

MindEval provided a bar graph (Addendum 5) for each surfer who completed the mental skills questionnaire. Each of the 12 mental skills was scored. The raw data was made available to the statistician.

3.6.3 Nutrition

Each food type was coded and entered against that surfer's research number. Food likes and dislikes were also coded.

This was an explorative study, and as such the hypotheses for this study were that physical attributes, mental skills and diet contributed to the success of the surfer. The Lindsay Carter and Heath (1990) somatotyping method is presently the most popular, largely because it is extremely versatile, and there are three different methods of obtaining a somatotype, namely anthropometric, photoscopic and the anthropometric plus photoscopic techniques. In order to obtain an anthropometric somatotype rating a total of 10 measurements must be taken. These measurements are height, mass, 4 skinfolds (triceps, sub-scapular, supraspinatus and medial calf), 2 bi-epicondylar diameters (humerus & Femur) and 2 circumferences (the flexed upper arm and calf). This study recorded 5 of the required measurements, and as such the participating surfers could not be somatotyped anthropometrically.

3.7 DISCRIMINANT ANALYSIS

Discriminant analysis is a statistical technique that uses a set of variables or measurements of various variables to allocate a person or object to a specific group. In this research we attempted to allocate a surfer to being either in the top 12 or not, based on the various measurements taken by the researcher. Surfers ranked 90th and above were excluded as their exact position in the competition was not captured. The variables utilized were the mental skills measured, as also the various anthropometric measurements.

The discriminant analysis was used as an exploratory technique to ascertain which variables were having an effect in discriminating/separating between the two groups of surfers. The forward stepwise procedure was used to construct two discriminant models. The first model utilized 12 variables, whilst the second model utilized 6 statistically significant variables

CHAPTER 4
Results

4.1 INTRODUCTION

This chapter presents the results of physical measurements, mental skills assessment and nutritional preferences of the u/20 surfers.

4.1.1 Population

A total of 107 u/20 surfers competed in one or more of the 5 Billabong contests in 2008. During the contest period, 41 surfers participated in the research. Of these 41 assessed, 27 surfers ended in the top 30 rankings at the end of 2008. For the final rankings, the best 4 contest results counted towards the surfers final rankings.

4.2 ANTHROPOMETRY

4.2.1 Anthropometrical measurements

Summary statistics for the surfer’s anthropometrical measurements can be found in Table 4.1. Age, height, weight, chest, waist, and hip circumference, and seven skinfolds were measured. Sample sizes vary due to incomplete assessments of some of the u/20 surfers because of logistical challenges. These challenges included the surfer being called away from the assessment due to his heat being advanced. In addition a few surfers left immediately after their unsuccessful last heat during a contest and did not present themselves again to the research team.

Table 4.1. Anthropometric measurements

	Valid N	Mean	Std.Dev.
Age (yrs)	40	16.30	1.86
Height (m)	41	1.71	0.07
Body mass (Kg)	39	63.34	7.63
Chest circumference (cm)	41	89.27	4.79
Waist circumference (cm)	41	74.07	4.21
Hip circumference (cm)	41	87.42	5.78
Chest skinfold (mm)	41	6.32	1.33
Mid axil skinfold (mm)	41	8.46	1.92
Triceps skinfold (mm)	41	9.26	2.37
Sub scap skinfold (mm)	41	9.67	2.49
Abdomen skinfold (mm)	41	11.99	3.40
Supra iliac skinfold (mm)	41	11.10	3.06
Thigh skinfold (mm)	40	13.27	3.45

* Sample sizes are different, due to observations not being recorded for some surfers

4.2.2 Body density, percentage body fat and body mass index

Figures 4.1, 4.2 and 4.3 indicate that the body densities, percentage body fat and to a lesser degree the body mass indices (BMI), represent a random sample from symmetrical populations.

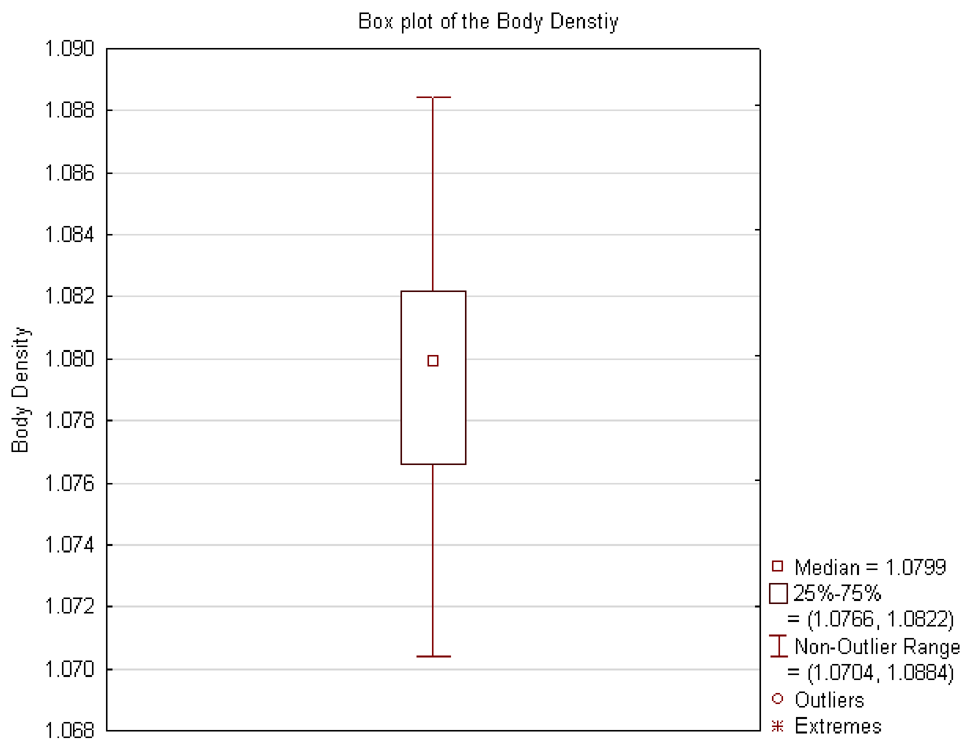


Figure 4.1 A box plot showing the distribution of the body density

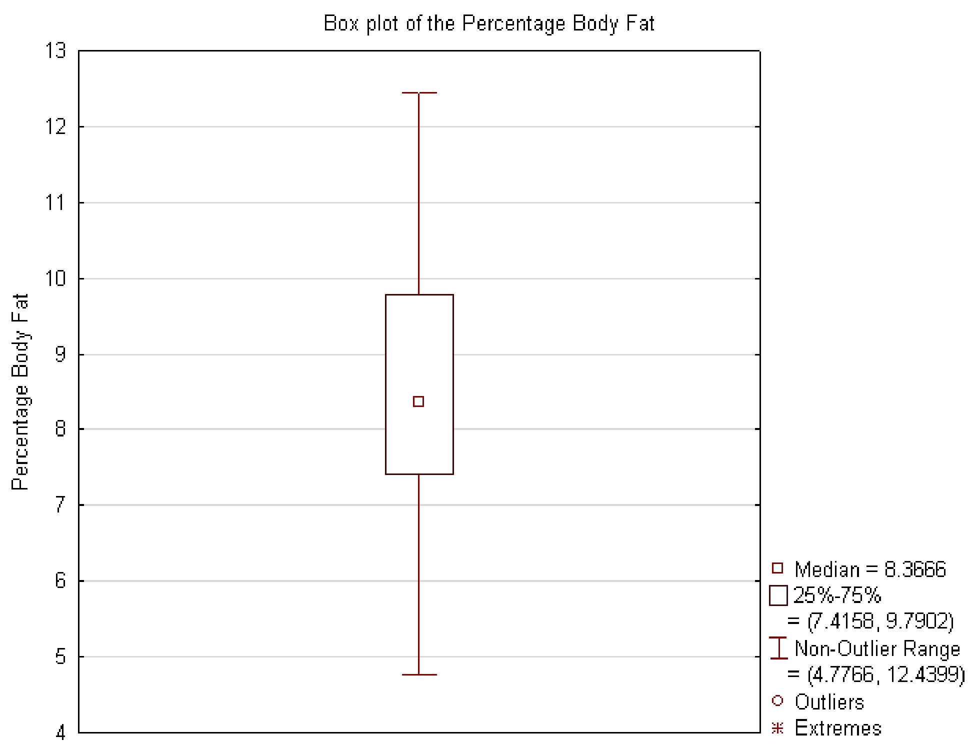


Figure 4.2 A box plot showing the distribution of the Percentage Body Fat

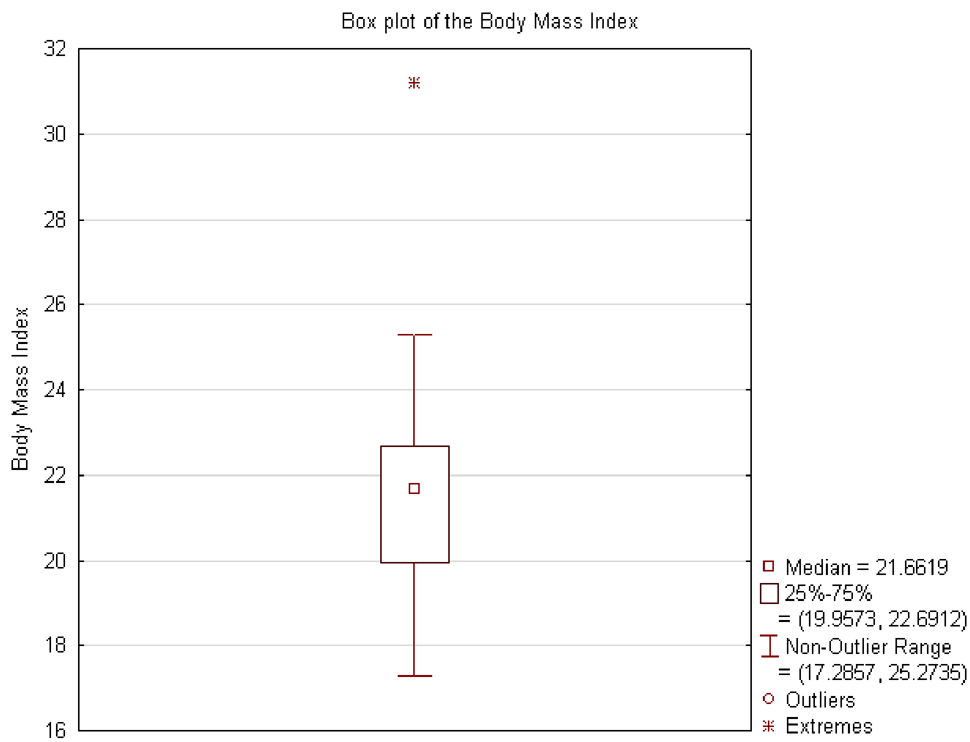


Figure 4.3 A box plot showing the distribution of the Body Mass Index

The average body density of the 38 surfers was 1.08 (g/ml) with a standard deviation of 0.01 (g/ml). The average percentage body fat of the 38 surfers was 8.55 % with a standard deviation of 1.85%. The average body mass index (BMI) of the 39 surfers was 21.57 kg/m^2 with a standard deviation of 2.40kg/m^2 (this included the outlier).

4.2.3 Body density, percentage body fat and body mass index compared between the various age groups

Null Hypothesis 1: There are no significant differences in the average body density values when compared between the various age groups.

Alternate Hypothesis 1: There are significant differences in the average body density values when compared between the various age groups.

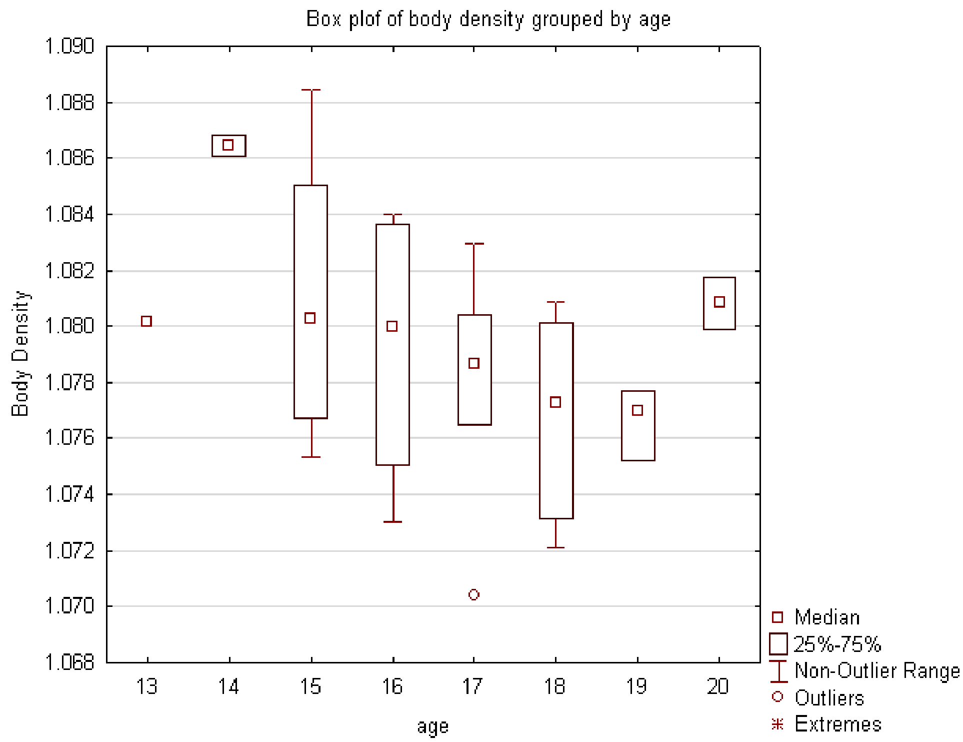


Figure 4.4 Box plots showing the distribution of the Body Density by Age group

As can be seen in Figure 4.4, the body densities grouped by age groups are from populations that are not symmetrically or normally distributed, nor are the variances within these groups equal (Levene's test for the homogeneity of variance F=1.48, df = 7,30, p-value =0.21). A non-parametric one-way analysis of variance, namely the Kruskall-Wallis ANOVA, indicated that for these data there were no significant differences between the median body density amongst the various age groups (H=9.93, df = 7, 38, p-value = 0.19).

Null Hypothesis 2: There are no significant differences in the average percentage body fat values when compared between the various age groups.
Alternate Hypothesis 2: There are significant differences in the average percentage body fat values when compared between the various age groups.

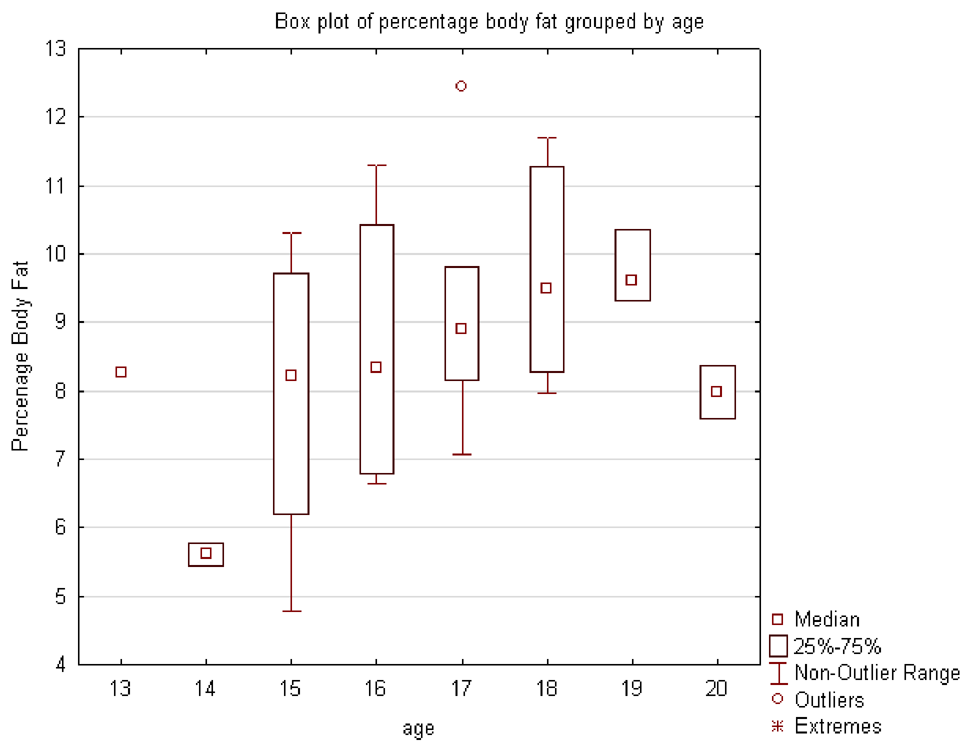


Figure 4.5 Box plots showing the distribution of the Body Fat by Age group

As can be seen in Figure 4.5, the percentage of body fat grouped by age groups are from populations that are not symmetrically or normally distributed, nor are the variances within the groups equal (Levene's test for the homogeneity of variance F=1.48, df = 7,30, p-value =0.21). A non-parametric one-way analysis of variance, namely the Kruskall-Wallis ANOVA, indicated that for these data there were no significant differences between the median percentage body fat amongst the various age groups (H=9.93, df = 7, 38, p-value = 0.19).

Null Hypothesis 3: There are no significant differences in the average body mass indices when compared between the various age groups.

Alternate Hypothesis 3: There are significant differences in the average body mass indices values when compared between the various age groups.

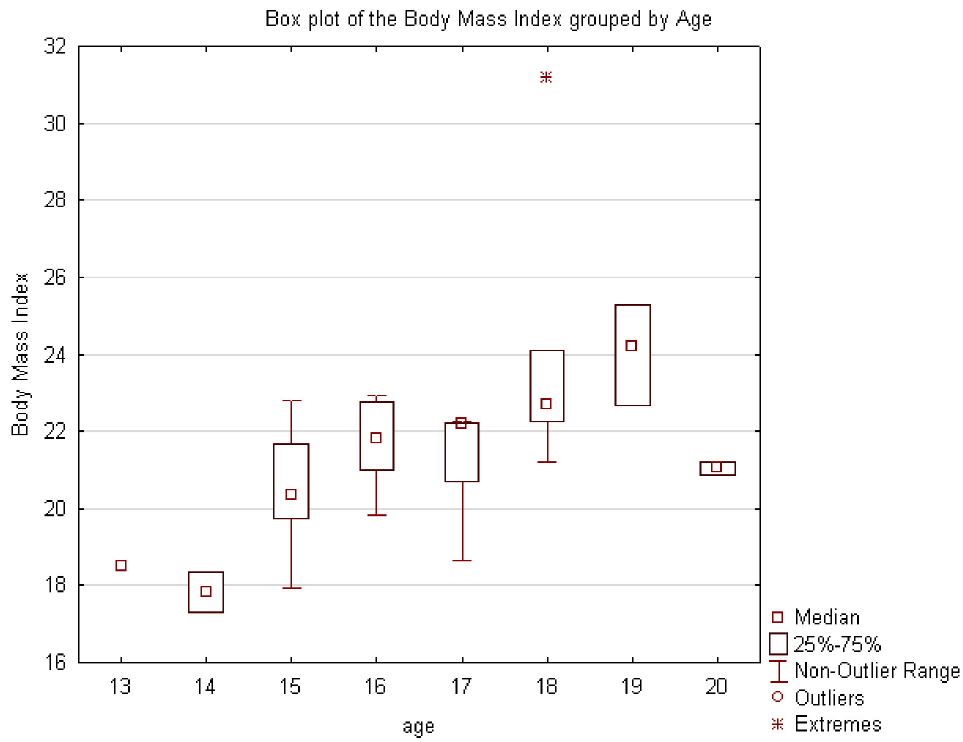


Figure 4.6 Box plots showing the distribution of the Body Mass Index by Age group

As can be seen in Figure 4.6, the body mass index grouped by age groups are from populations that are not symmetrically or normally distributed, nor are the variances within the groups equal (Levene's test for the homogeneity of variance F=1.01, df = 7, 28, p-value = 0.44). A non-parametric one-way analysis of variance, namely the Kruskall-Wallis ANOVA, indicated that for these data there were significant differences between the median body mass indices amongst the various age groups (H=19.42, df = 7, 36, p-value = 0.007). Multiple comparisons using Scheffe's procedure, showed no significant differences between individual groups at the 5% level of significance. However, the body mass index of age group 14 was significantly lower than that of age group 19 (p = 0.05077) and age group 18 (p = 0.08) at the 10% level of significance.

4.2.4 Body density, percentage body fat and body mass indices grouped by rank

In this category, the body density, percentage body fat and body mass indices of the top 12 surfers in the sample were compared with the lower ranked surfers.

Null Hypothesis 4: There are no significant differences in the average body density, percentage body fat and body mass indices when compared between the top 12 surfers and the other surfers in this study.
Alternate Hypothesis 4: There are significant differences in the average body density, percentage body fat and mass indices when compared between the top 12 surfers and the other surfers in this study.

The results of this section are summarized in Table 4.2 and discussed in the paragraphs that follow.

Table 4.2 Average body density, percentage body fat and body mass index: Top 12 compared to the rest

	Mean Rest	Mean Top 12	t-value	p	Valid N Rest	Valid N Top 12	SD Rest	SD Top 12
Body Density	1.08	1.08	1.53	0.14	27	10	0.004	0.004
% body fat	8.28	9.32	-1.53	0.13	27	10	1.843	1.826
BMI	21.02	23.23	-2.55	0.02	29	9	1.876	3.286

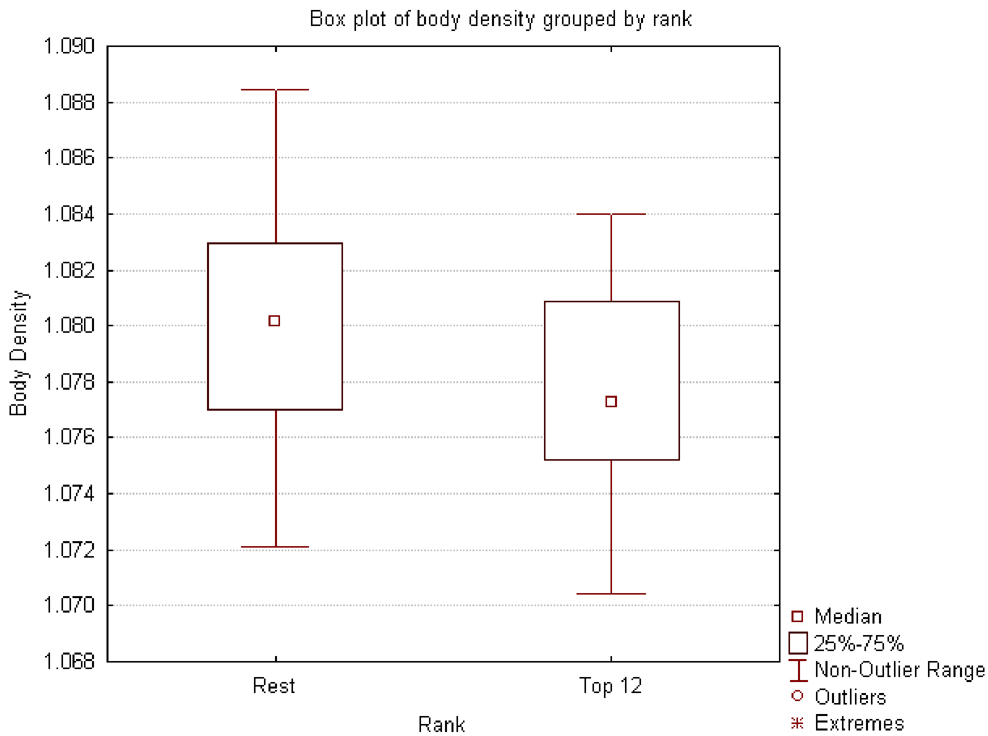


Figure 4.7 Box plots showing the distribution of the Body Density group by rank

As can be seen in Figure 4.7 the body densities grouped by rank, that is the top 12 surfers when compared to the rest of the surfers in this study, are from populations that are symmetrically distributed. The top 12 surfers have an average body density of 1.08g/ml with a standard deviation of 0.004. The rest of the surfers have an average body density of 1.08g/ml with a standard deviation of 0.004. The variances within the groups are equal (Levene's test for the homogeneity of variance F = 0.002, df = 1,35, p-value = 0.97). A two-sample t-test, with equal population variances, indicated that for these data there were no significant differences between the average body densities between the top twelve ranked competitors and the rest of the competitors (t = 1.53, df = 35, p-value = 0.14).

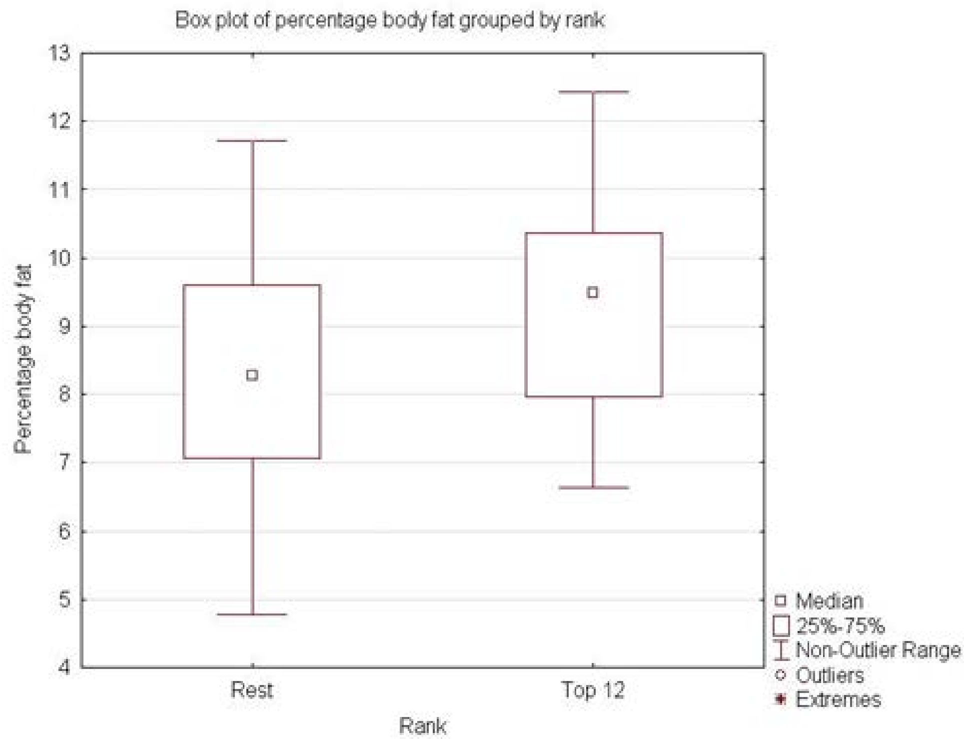


Figure 4.8 Box plots showing the distribution of the Percentage Body Fat group by rank

As can be seen in Figure 4.8, the percentage body fat as grouped by rank (top 12 against the rest) are from populations that are symmetrically distributed. The top 12 surfers have an average percentage body fat of 9.32%, with a standard deviation of 1.826%. The rest of the surfers have an average body fat of 8.28% with a standard deviation of 1.843%. The variances within the groups are equal (Levene's test for the homogeneity of variance F = 0.004, df = 1, 35, p-value = 0.95). A two-sample t-test, with equal population variances, indicated that for these data there were no significant differences between the average percentage body fat between the top twelve ranked competitors and the rest of the competitors (t = -1.53, df = 35, p-value = 0.13).

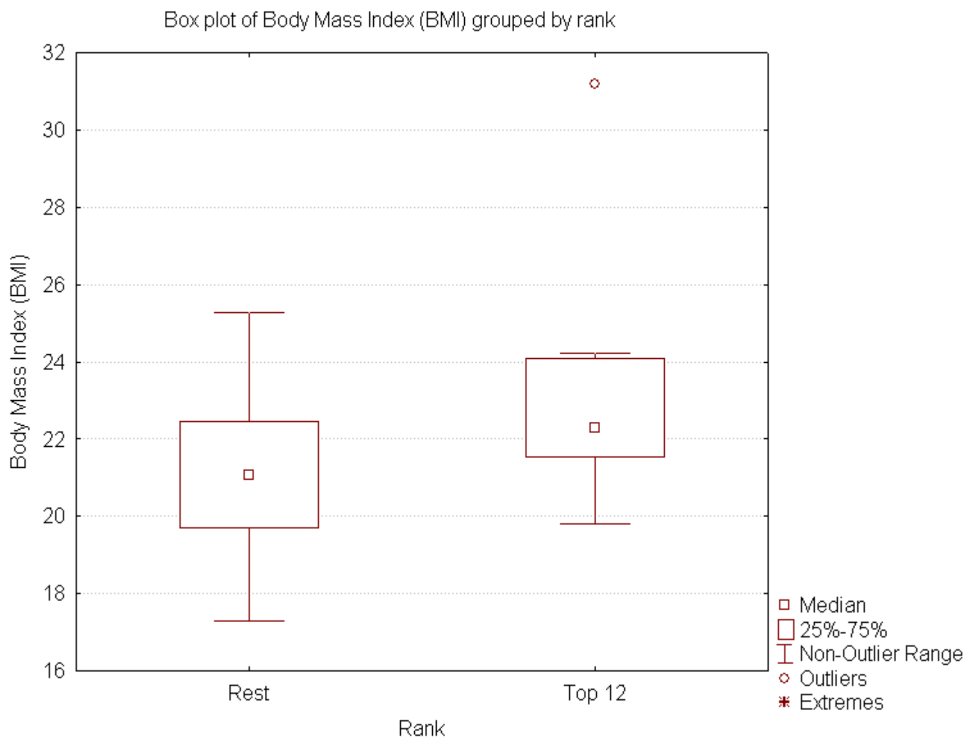


Figure 4.9 Box plots showing the distribution of the Body Mass Index group by rank

As can be seen in Figure 4.9, the body mass index grouped by rank (top 12 against the rest) are from populations that are possibly not symmetrically distributed. The top 12 surfers have a body mass index of 23.23 kg/m^2 with a standard deviation of 3.286kg/m^2. The rest of the surfers have an average body mass index of 21.02 kg/m^2 with a standard deviation of 1.876kg/m^2. The variances within the groups are equal (Levene's test for the homogeneity of variance F = 1.47, df = 1, 36, p-value = 0.24). A two-sample t-test, with equal population variances, indicated that for these data there were significant differences between the average body mass index between the top twelve ranked competitors and the rest of the competitors (t = -2.55, df = 36, p-value = 0.15).

4.2.5 Height and Age

In this section, it was tested whether there are significant differences between the age, height and the ranking of the surfers.

Null Hypothesis 5: There is not a significant linear relationship between the rank and the age of the surfer.

Alternate Hypothesis 5: There is a significant linear relationship between the rank and the age of the surfer.

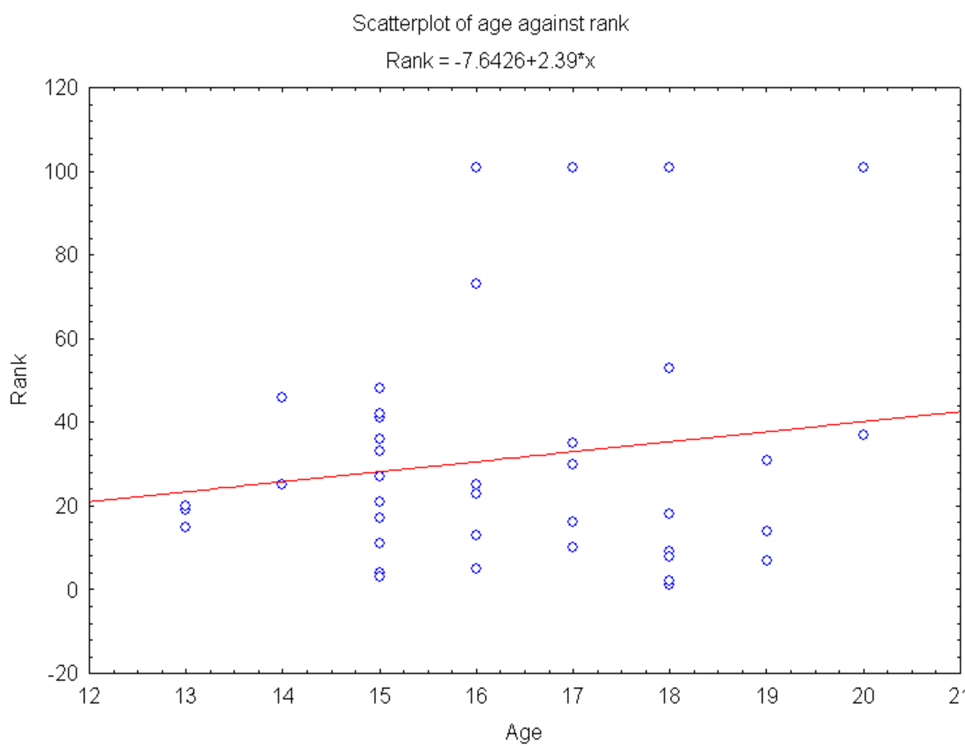


Figure 4.10 Scatter plot of the rank of a surfer and their age

Figure 4.10 indicates that there is probably not a significant linear relationship between the rank and the age of the surfers. The fitted simple linear regression indicates that there is not a significant linear relationship, $F=0.94$, d f = 1, 37, p-value <0.39, between rank and age.

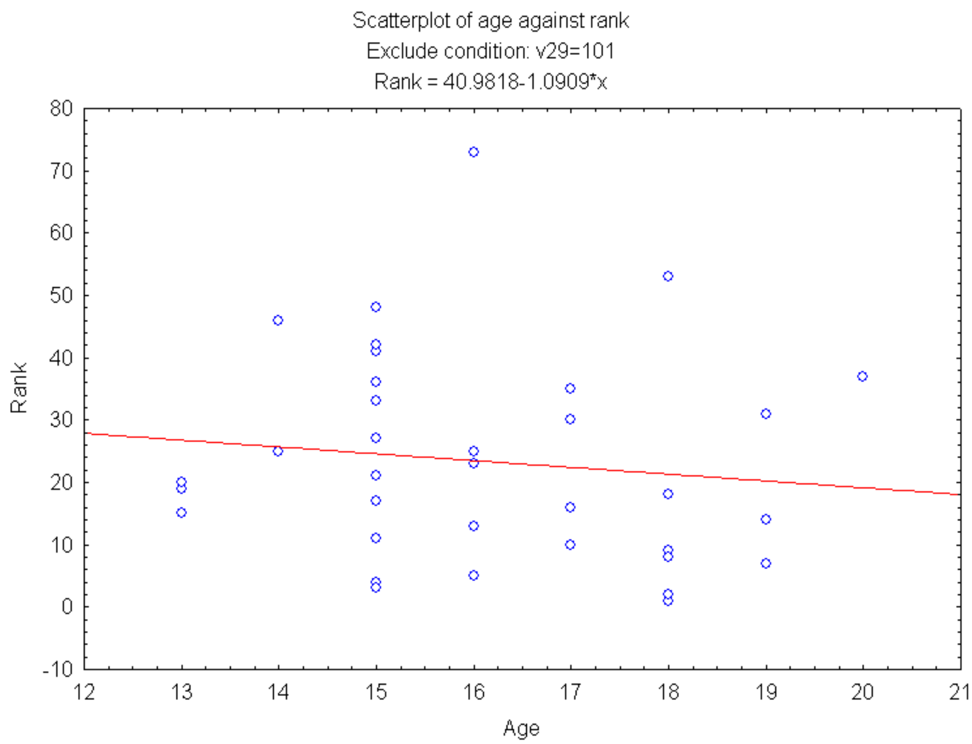


Figure 4.11 Scatter plot of the rank of a surfer and their age (above 90th position removed)

Null hypothesis 6: There is not a significant relationship between the rank and height of the surfer

Alternate hypothesis 6: There is a significant linear relationship between the rank and height of the surfer

Figure 4.12 indicates that there is probably not a significant linear relationship between the rank and the height of the surfers. The fitted simple linear regression indicates that there is not a significant linear relationship, F = 0.09, d f = 1, 38, p<0.77, between rank and height.

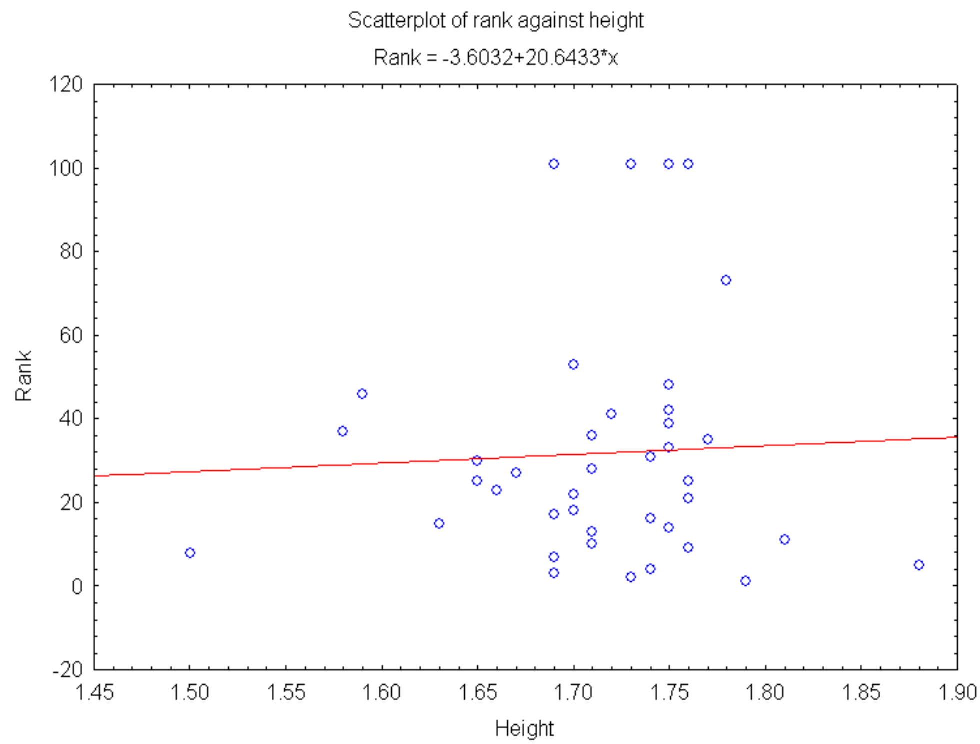


Figure 4.12 Scatter plot of the rank of a surfer and their height (above 90th position removed)

Note that all surfers who finish above 90th position in a competition are all coded as the same value, that is their exact final position is not recorded. These four surfers are hence marked with rank 101 in the figure above. However removing these four surfers from the analysis does not affect the conclusion as the fitted simple regression model is still not significant: $F = 0.07316$, $d\,f = 1, 34$, $p < 0.78843$.

4.2.6 Body circumference measurements

4.2.6.1 Waist to hip ratio

The waist to hip ratio is defined as the waist circumference in cm divided by the hip circumference in cm of the u/20 surfers.

Null Hypothesis 7: There is not a significant linear relationship between the rank and the waist to hip ratio of the u/20 surfer.

Alternate Hypothesis 7: There is a significant linear relationship between the rank and the waist to hip ratio of the u/20 surfer.

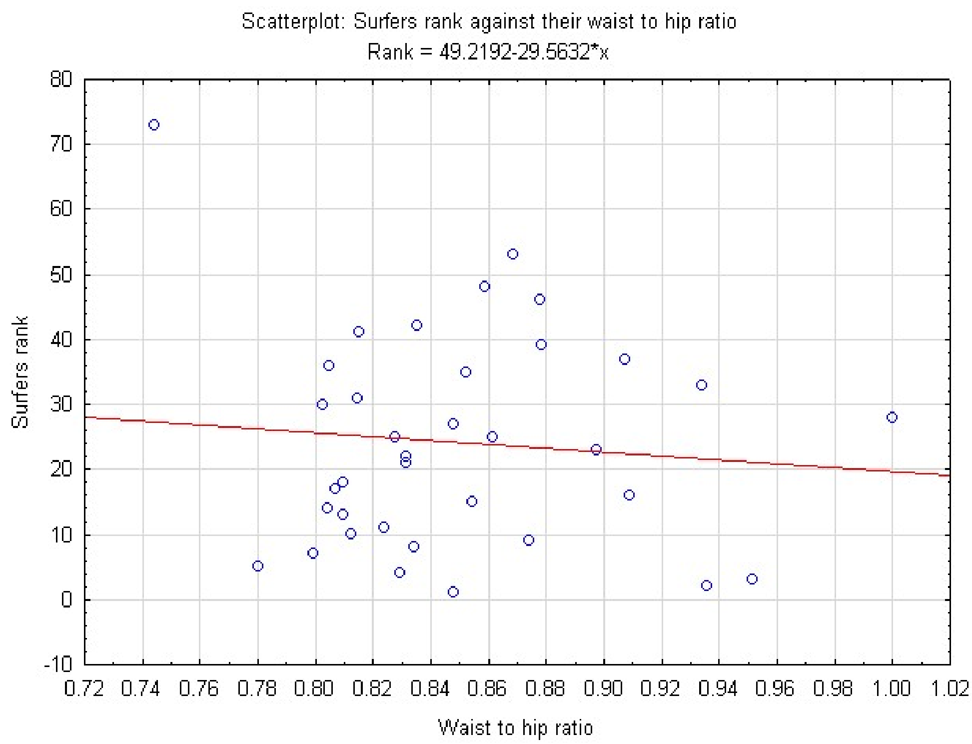


Figure 4.13 A scatterplot of the rank of a surfer and their waist to hip ratio

A linear regression model was fit to the data. The linear relationship between the rank of a surfer and their waist to hip ratio is not significant ($F(1,34) = 0.29970$ $p<0.58765$) (Figure 4.13) . Those surfers who finished above 90th were removed for this analysis.

4.2.6.2 Chest to waist ratio

The chest to waist ratio is defined as the surfers' chest circumference in cm divided by their waist measurement in cm.

Null Hypothesis 8: There is not a significant linear relationship between the rank and the chest to waist ratio of the u/20 surfer.

Alternative Hypothesis 8: There is a significant linear relationship between the rank and the chest to waist ratio

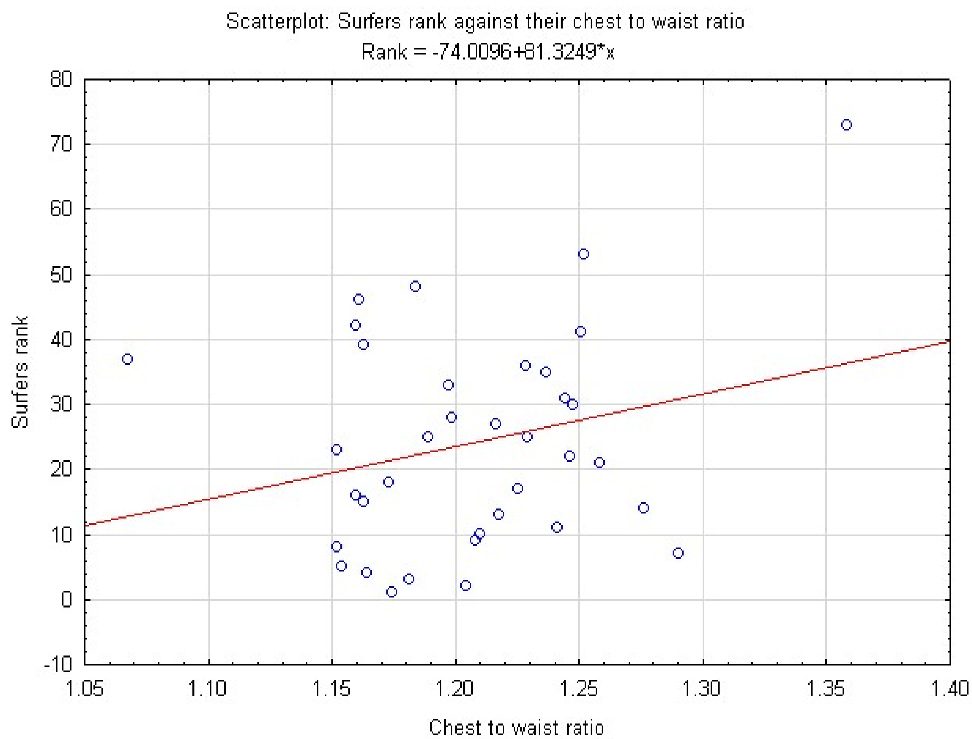


Figure 4.14 A scatterplot of the rank of a surfer and their chest to waist ratio

Figure 4.14 shows evidence of a positive linear relationship between the surfers rank and their chest to waist ratio. A linear regression model was fit to the data. The linear relationship between the rank of a surfer and their chest to waist ratio is not significant ($F(1,34) = 2.3531$ $p<0.13429$). Those surfers who finished above 90th were removed from this analysis.

4.2.6.3 Chest to hip ratio

The chest to hip ratio is defined as the chest circumference in cm of the u/20 surfer divided by the hip circumference in cm.

Null Hypothesis 9: There is not a significant linear relationship between the rank of a surfer and his chest to hip ratio.
Alternate Hypothesis 9: There is a significant relationship between the rank of a surfer and his chest to hip ratio.

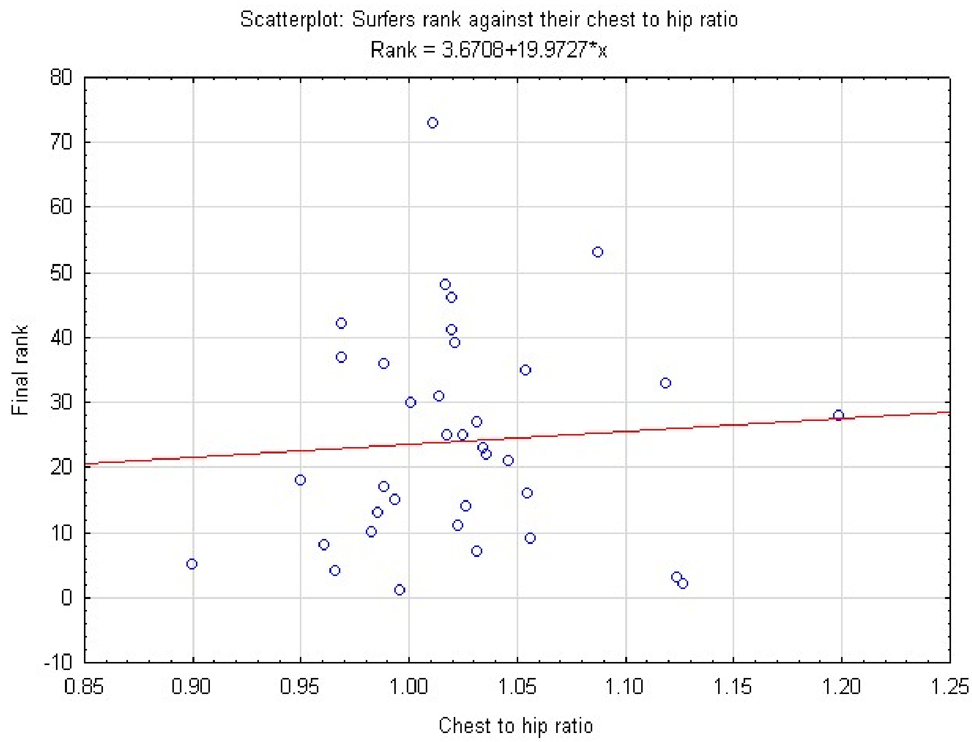


Figure 4.15 A scatterplot of the rank of a surfer and his chest to hip measurement

Figure 4.15 shows no evidence of either a linear or non- linear relationship between the surfers rank and his chest to hip ratio. A linear regression model was fit to the data. The linear relationship between the rank of a surfer and his chest to hip ratio is not significant ($F (1,34)=0.15682$ $p<0.69458$). Those surfers who finished above 90^{th} were removed from this analysis.

4.3 MENTAL SKILLS

Forty one (41) surfers were administered the OMSAT mental skills questionnaire. The average mental skills, as measured by the OMSAT instrument are shown in the Table 4.3 below. Box plots are used to summarize the distribution of these variables graphically in the Figure 4.16.

Table 4.3 A summary of the OMSAT mental skills questionnaire

	N	Means	SD
Goal-Setting	41	5.48	0.73
Self-Confidence	41	6.06	0.63
Commitment	41	6.23	0.65
Stress Reactions	41	3.87	1.32
Fear Control	41	4.65	1.17
Relaxation	41	4.55	1.35
Activation	41	5.33	1.19
Focusing	41	4.56	1.31
Refocusing	41	3.81	1.19
Imagery	41	5.37	1.16
Mental Practice	41	4.97	1.07
Competition Planning	41	4.80	1.31
All Groups	492	4.97	1.32

The above values represent the degree of competency of the specified mental skill, with 1 having being incompetent and 7 being most competent

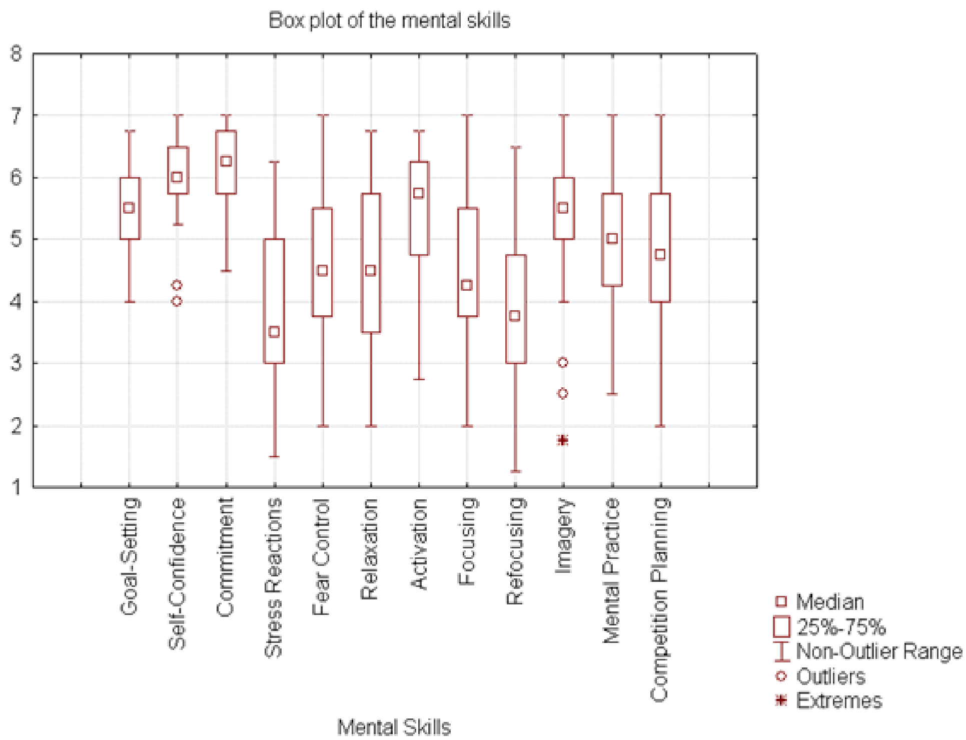


Figure 4.16 Box plots of the various mental skills scores for these surfers

A one-way analysis of variance (ANOVA) was utilized to compare the average scores of these surfers' scores on the various mental skills scales:

Null Hypothesis 10: There are no significant differences in the average scores for the OMSAT mental skill variables, namely Goal-Setting, Self-Confidence, Commitment, Stress Reactions, Fear Control, Relaxation, Activation, Focusing, Refocusing, Imagery, Mental Practice and Competition Planning, for these surfers.

Alternate Hypothesis 10: There are significant differences in the average scores for the OMSAT 3 mental skill variables, namely Goal-Setting, Self-Confidence, Commitment, Stress Reactions, Fear Control, Relaxation, Activation, Focusing, Refocusing, Imagery, Mental Practice and Competition Planning, for these surfers. Irrespective of the ranking of the surfers, as a group they have mastered some mental skills and not others.

Table 4.4 Scheffe's post hoc showing the significant differences between the various mental skills

	Goal-Setting	Self-Confidence	Commitment	Stress Reactions	Fear Control	Relaxation	Activation	Focusing	Refocusing	Imagery	Mental Practice	Competition Planning
	M=5.48	M=6.06	M=6.23	M=3.87	M=4.65	M=4.55	M=5.33	M=4.56	M=3.81	M=5.37	M=4.97	M=4.80
Goal-Setting		0.89	0.58	0.01	0.36	0.18	1	0.21	0.01	1	0.94	0.72
Self-Confidence	0.89		0.99	0	0.01	0.01	0.62	0.01	0	0.71	0.04	0.01
Commitment	0.58	0.99		0	0.01	0.01	0.25	0.01	0	0.33	0.01	0.01
Stress Reactions	0.01	0.01	0		0.51	0.73	0.01	0.69	1	0.01	0.04	0.19
Fear Control	0.36	0.01	0.01	0.51		1	0.71	1	0.38	0.62	0.99	0.99
Relaxation	0.18	0.01	0.01	0.73	1		0.48	1	0.6	0.39	0.99	0.99
Activation	1	0.62	0.25	0.01	0.71	0.48		0.52	0.01	1	0.99	0.94
Focusing	0.21	0.01	0.01	0.69	1	1	0.52		0.56	0.43	0.99	0.99
Refocusing	0.01	0	0	1	0.38	0.6	0.01	0.56		0.01	0.02	0.12
Imagery	1	0.71	0.33	0.01	0.62	0.39	1	0.43	0.01		0.99	0.9
Mental Practice	0.95	0.04	0.01	0.04	0.99	0.99	0.99	0.99	0.02	0.99		0.99
Competition Planning	0.72	0.01	0.01	0.19	0.99	0.99	0.94	0.99	0.12	0.89	0.99	

The averages of the various mental skill scores were found to be significantly different, F=19.78, d f = 11,504, p ≈ 0.00. As can be seen in the Table 4.4, the mental skill that scored highest was the commitment skill, average score of 6.23, while the lowest mental skills were the stress reactions, average score of 3.87, and refocusing skills, average score of 3.81. Scheffe's post hoc test was utilized to identify significant differences between the various mental skills. The results of this test are shown in Table 4.5 below.

Table 4.5 Comparison of the mental skills of the top 12 surfers' vs the rest

Mental Skill	Mean		t-value	p	Valid N		SD	
	Top 12	Rest			Top 12	Rest	Top 12	Rest
Goal Setting	5.400	5.446	-0.170	0.866	10	31	0.827	0.708
Self Confidence	6.200	5.991	0.857	0.397	10	31	0.524	0.702
Commitment	6.325	6.196	0.572	0.571	10	31	0.657	0.595
Stress Reaction	3.875	3.821	0.106	0.916	10	31	1.533	1.310
Fear Control	4.600	4.705	-0.237	0.814	10	31	0.747	1.327
Relaxation	4.450	4.652	-0.404	0.689	10	31	1.404	1.339
Activation	5.500	5.214	0.619	0.540	10	31	1.333	1.226
Focusing	4.100	4.804	-1.406	0.168	10	31	1.542	1.292
Refocusing	4.000	3.830	0.380	0.707	10	31	0.833	1.316
Imagery	4.875	5.429	-1.281	0.208	10	31	1.243	1.148
Mental Orientation	4.925	4.964	-0.103	0.919	10	31	1.137	0.999
Competition	4.800	4.696	0.204	0.840	10	31	1.494	1.339

Univariate two sample t-tests were used to test for significant difference in the average mental skills of the top 12 surfers when compared to the rest for each of the OMSAT mental skills. Levene's test for the homogeneity of variances, for each mental skill, indicated that the variances were equal in all cases. As a result the pooled variance was used in the t-test for each mental skill. The results are shown in the table below.

No significant differences between the top 12 and the rest of the surfers were found on any of the mental skills

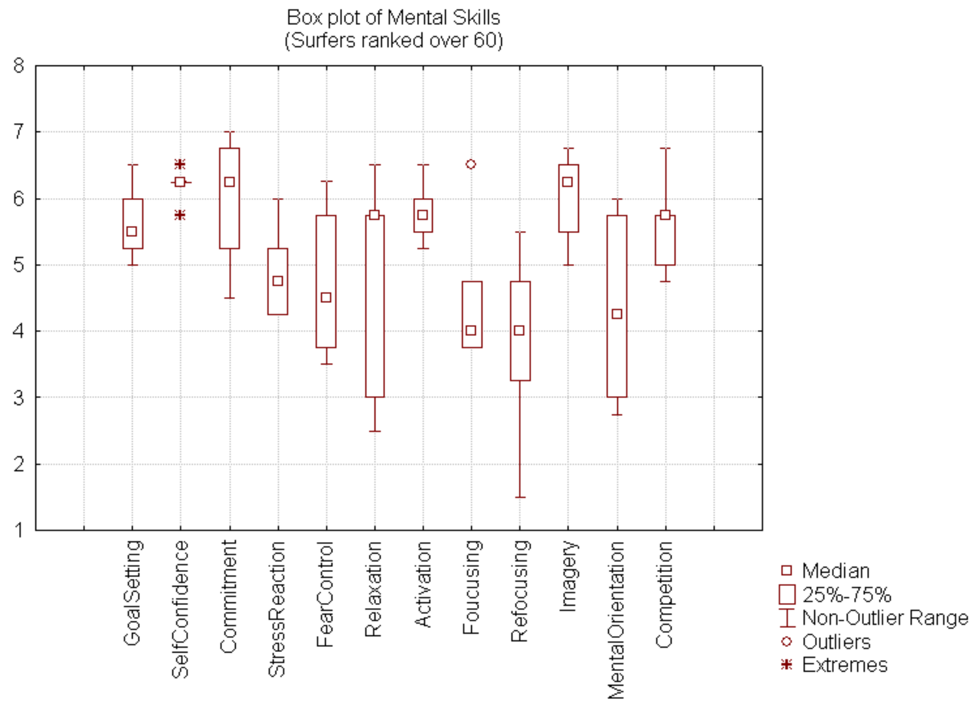


Figure 4.17 Box plots of the various mental skills scores for those surfers ranked over 60th

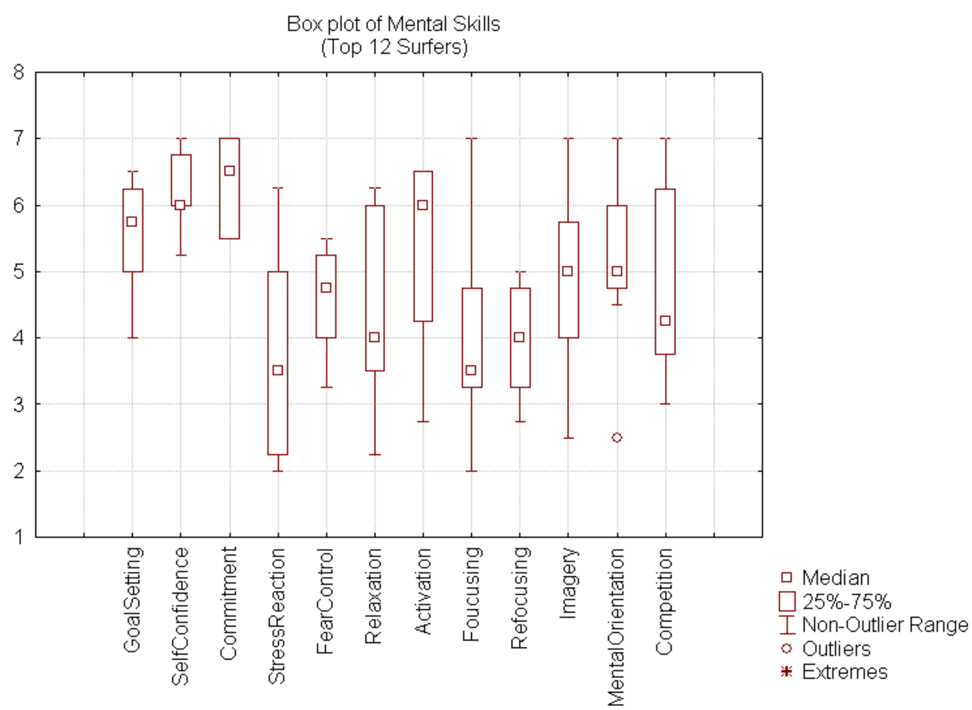


Figure 4.18 Box plots of the various mental skills scores for those surfers ranked in the top 12

4.4 NUTRITION

Figure 4.19 represents the number of surfers consuming a particular food or drink during the immediate 24 hours preceding a contest heat. Food and fluids freely available were noted. From the dietary interviews, it was quite clear that no particular eating regime is being practiced by the surfers during the competition. The surfers tended to utilize food and drink which was freely available. Favorite foods were sandwiches, cheeses, fast foods (Wimpy, McDonalds and Steers) and red meats. Frequently ingested fluids were soft drinks, milkshakes, fruit juices and water. Less frequently utilized foods were energy bars, sausages, ham, fish, yoghurt and macaroni.

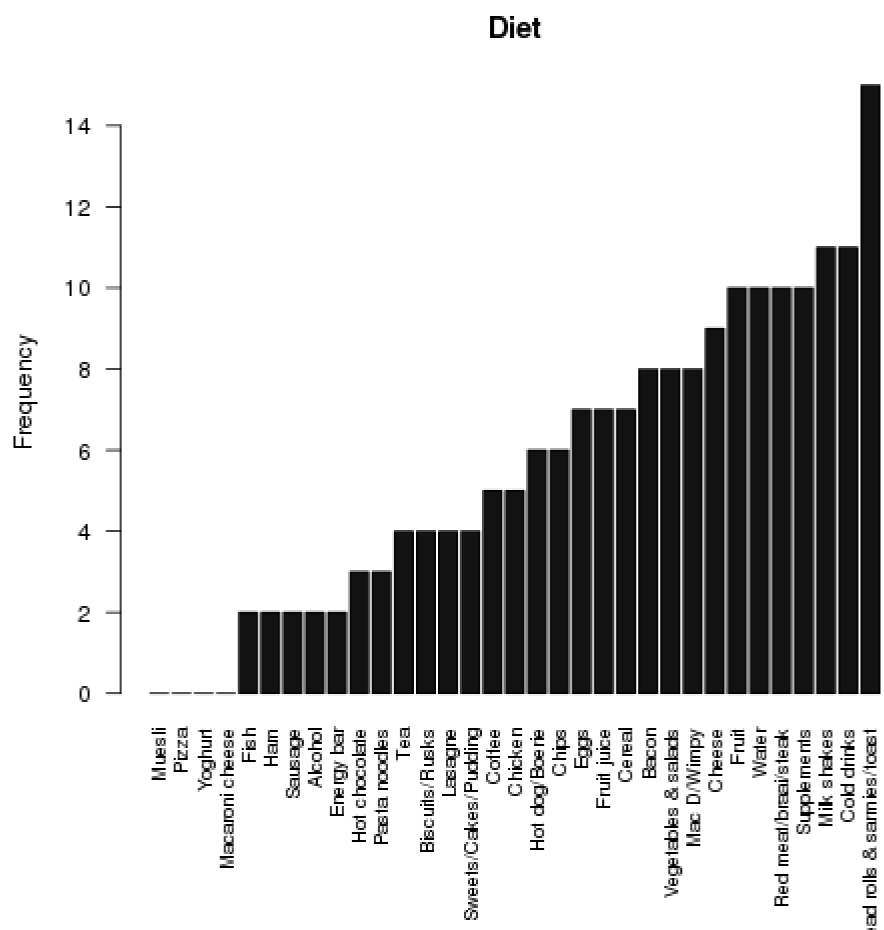


Figure 4.19 The number of surfers eating or drinking the listed food and fluids during 24 hours preceding their competitive heat

4.5 DISCRIMINANT ANALYSIS

A forward stepwise discriminant analysis (Wilks' Lambda: 0.35 approx. F (12.21) =3.21 p< 0.0095) was performed on the ranked overall classification of the surfers (top 12 against the rest). The fitted model and associated results are shown in the table below as is the classification matrix. Note that the algorithm in Statistica ignores cases with missing data. This model performs well in that approximately 94.6% of the surfers are correctly assigned to the relevant classes (see Table 4.7). In Table 4.7, rows are the observed classifications, while columns are the predicted classifications. The forward stepwise procedure is utilizing the Body Mass Index, Imagery, Mental Orientation, Self Confidence, Ratio 2 (Chest/Waist), Thigh skinfold measurement, Refocusing, Focusing, Height, Fear Control, Weight and Commitment variables.

Table 4.6 Summary of the variables in the forward stepwise discriminant analysis

	Wilks' Lambda	**Partial Lambda**	**F-remove (1,21)**	**p-level**	**Toler.**	**1-Toler. (R-Sqr.)**
BMI	0.43	0.82	4.63	0.04	0.01	0.99
Imagery	0.58	0.60	13.54	0.01	0.43	0.57
Mental Orientation	0.45	0.78	5.87	0.02	0.38	0.62
Self Confidence	0.38	0.93	1.47	0.23	0.71	0.29
Ratio2	0.36	0.98	0.49	0.49	0.68	0.32
Thigh	0.37	0.95	1.09	0.31	0.80	0.20
Refocusing	0.50	0.71	8.78	0.01	0.27	0.73
Focusing	0.45	0.79	5.69	0.03	0.41	0.59
Height	0.42	0.84	4.06	0.06	0.01	0.99
Fear Control	0.41	0.86	3.40	0.08	0.46	0.54
Weight	0.41	0.86	3.32	0.08	0.01	0.99
Commitment	0.37	0.95	1.05	0.32	0.64	0.36

Table 4.7 Classification Matrix for the forward stepwise discriminant analysis

	Percent Correct	**Top 12 p=0.23529**	**Rest p=0.76471**
Top 12	87.5	7	1
Rest	96.6	1	28
Total	94.6	8	29

Not all of the 12 independent variables are significant in the model (see Table 4.8). Significant variables in the model have a p-level less than 0.05. This results in
a different discriminant function. Only approximately 85.2% of the surfers are correctly assigned to a class or category (see Table 4.9). This discriminant function (Wilks' Lambda: 0.55 approx. F (6,23)=3.18 p< 0.02) includes only 6 variables, namely the Body Mass Index, Imagery, Mental Orientation, Self Confidence, Ratio2 (Chest / Waist) and Fear Control but not thigh skinfold measurement, Refocusing, Focusing, Height, Weight and Commitment variables (see Table 4.8).

Table 4.8 Summary of the variables in the forward stepwise discriminant analysis

	Wilks' Lambda	**Partial Lambda**	**F-remove (1,23)**	**p-level**	**Toler.**	**1-Toler. (R-Sqr.)**
BMI	0.78	0.70	9.95	0.01	0.65	0.35
Imagery	0.71	0.77	6.95	0.01	0.62	0.38
Self Confidence	0.63	0.87	3.49	0.07	0.81	0.19
Ratio x2	0.58	0.94	1.35	0.26	0.80	0.20
Mental Orientation	0.60	0.91	2.22	0.15	0.56	0.44
Fear Control	0.57	0.96	1.06	0.31	0.64	0.36

Table 4.9 Classification Matrix for the forward stepwise discriminant analysis.

	Percent Correct	**Top 12 p=0.27**	**Rest p=0.73**
Top 12	55.6	5	4
Rest	96.0	1	24
Total	85.2	6	28

* Rows are the observed classifications while columns are the predicted classifications. Surfers ranked 90th or above were removed for this analysis

The above classification Matrix (Table 4.9) of the forward stepwise discriminant analysis only included 6 variables. This resulted in 55.6% of the surfers in the top 12 being correctly assigned. The rest were correctly assigned in 96% of cases.

4.6. SUMMARY

In this chapter, the results of several variables measured in the 2008 u/20 Billabong surfers were presented and tested for statistical significance. Statistically significant findings were:

- The BMI of the 14 yr old surfers was significantly lower when compared to the 18 yr olds and 19 yr olds. (Figure 4.3)
- Six variables were found to be significant when applying a forward stepwise discriminant analysis to assign a surfer to the top 12 category or a lower category (Table 4.8). These variables were Body Mass Index, Imagery, Mental Orientation, Self Confidence, Ratio 2(chest/waist) and Fear Control.
- Commitment skills scored the highest, whilst stress reactions and refocusing skills scored the lowest in the mental skills (Figure 4.16).

No statistical significance was found between the various age groups and:

- Median body density (Figure 4.4)
- Median percentage body fat (Figure 4.5)

No statistical difference was found between the surfers finishing in the top 12 and the rest when comparing the final 2008 rankings and the following variables:

- Body density (Figure 4.7)
- Percentage body fat (Figure 4.8)
- Body mass index (Figure 4.9)
- Age (Figure 4.10 and Figure 4.11)
- Height (Figure 4.12)
- Waist to hip ratio (Figure 4.13)
- Chest to waist ratio (Figure 4.14)
- Chest to hip ratio (Figure 4.15)
- Mental skills (Figure 4.17 and Figure 4.18)

The results will be discussed in Chapter 5.

CHAPTER 5

Discussion

5.1 INTRODUCTION

The aim of this study was to assess the anthropometric characteristics, mental skills and nutritional preferences of the 2008 u/20 Billabong surfers. This study attempted to identify variables which influenced the final rankings (top 12 against the rest) of the surfers at the end of the competitive surfing season. Variables which could be measured on the beach rather than in a laboratory were selected. Laboratory tests such as VO_2 max were nor related to surfers ranking positions. [Mendez-Villaneuva et al., (2005); Camara et al., (2011]). An analytical and descriptive study design was utilized to achieve this aim.

The competitive surfer and his support team (family, coach and sponsors) spend a lot of time, effort and money in attempting to achieve a top ranking for the surfer. Due to contest and training commitments, the u/20 surfer is often home schooled, and as such may not be able to participate in team sports and life skills development programs which are part of the high school curriculum in South Africa. For the surfer and his family, identifying variables which could improve his overall performance and competitive skills should result in improved surfing performance and results. Similarly, the study outcomes should assist coaches and sponsors in identifying young surfers with potential, as also identify variables for a particular surfer which need to be addressed in an attempt to improve the contest results for that surfer.

The results have been assessed for comparative purposes with existing research on elite surfers. An attempt was made via a forward stepwise discriminant analysis to predict whether a surfer could end the season within the top 12 rankings (Table 4.7 and Table 4.9).

The results have been assessed for comparative purposes with existing research on elite surfers. Farley (2011) notes the paucity of published literature which exists for surfing, with the ability to obtain data from participants being hindered. Camara et al., (2011) and Lima et al.,(2011) similarly note the literature on surfing is sparse with only a few authors and works in the area of surfing physiology.

Previous research findings utilized for comparison were the following:

5.1.1 Anthropometry

- Elite surfers display specific size attributes, specifically lower height and body mass when compared with other matched aquatic athletes (Mendez-Villaneuva and Bishop, 2005).
- Surfers have an increased % body fat when compared with other level matched athletes (Mendez-Villanueva and Bishop 2005)
- Barlow et al., (2012) note a correlation between endomorphy, mesomorphy, the sum of 6 skin fold and body fat % with the surfers ranking.

5.1.2 Mental Skills

- The mental environment is more important than the physical traits of the surfer (Thomen, 2009)
- Self Confidence, Commitment and Goal Setting are the best discriminating scales between elite and less competitive athletes (Bota, 1993)
- Focusing is an important mental skill

5.1.3 Nutrition

- During surfing competitions, carbohydrate and confectionery intake was significantly higher than protein intake (Felder et al., 1998)

5.1.4 Discriminant Analysis

- Mendez-Villanueva et al., (2010) concluded that competition outcomes are relatively unpredictable

5.2 ANTHROPOMETRIC RESULTS

Anthropometric profiles of the participants were drawn from the percentage body fat, body mass indices and body densities to explore whether there were differences between the surfers of various age groups, as well as differences between those who finished within the top 12 rankings and those who did not. Table 4.1 shows the average mass of the u/20 surfers to be 63.35 ±7.62 kg, with average age 16.3 ± 1.86 yr.

Average Body Mass Index was 21.57 kg/m^2 (std. deviation 2.40kg/m^2), average body density 1.08g/ml (std. deviation 0.004g/ml) and average percentage body fat 8.55 % (std. deviation 1.85%). The Body Mass Index is age and sex specific, and the Centers for Disease Control and Prevention (CDC) age for growth charts were used to obtain a percentile ranking for Mass and Body Mass Index. Plotting the BMI results for 38 surfers, 21 were between the 50th and 75th percentiles, 9 between the 25th and 50th percentiles. There were 4 u/20 surfers between the 10th and 25th percentiles, and 4 surfers were plotted greater than the 75th percentile (Figure 2.2.1). When plotting the mass of 39 surfers, 28 were above the 50th percentile, and 11 below the 50th percentile (Figure 2.2.2). Based on the findings from Mendez-Villanueva and Bishop, (2005) as well as Lowden and Pateman, (1980), it was expected the surfers would have a mesomorph somatotype with similar body fat percentages and body densities. The average % body fat of the u/20 surfers (Table 4.1) is lower than that reported by Mendez-Villanueva and Bishop, (2005) and The Sports Institute of South Africa (SSISA). The latter report an average % body fat for their u/16 National Surfers of 14.5%, and the u/20 National surfers a % body fat of 13.2 %. When comparing the higher % body fat reported in the SSISA assessments, it is necessary to know which prediction equation was used to estimate % body fat. The prediction equations used to predict body fat need to be population specific in terms of gender, race, age and activity level (Davies and Cole, 1995). Skinfold measurements are susceptible to many sources of error, these being that measurement sites need to be exactly located and only subcutaneous fat must be measured. Calipers compress the fatty tissue; therefore sufficient time must be given before re-measuring. The effect of the wetsuits on skin fold measurements, with possible compression of the subcutaneous fat, must be considered.

Our study considered the possibility that the u/20 surfers would have an increasing % body fat with increasing age (Figure 4.5) due to the fact that the older the surfer, the greater the time he has cumulatively spent in the sea, and cold water, hence the increase in % body fat (Mendez- Villanueva and Bishop, 2005). Our results noted that % body fat remained constant, which can be attributed to improved wet suit design. When comparing the higher percentage body fat reported by Mendes-Villanueva and Bishop, (2005), it could be attributed to the fact that their surfers were older and thus could theoretically have spent more accumulated time in colder sea water, resulting in increased body fat percentages to assist thermoregulation. (Lowden and Pateman, 1980)

Based on the National Health Statistics Report U.S. 1999-2004, it was also expected that body mass indices would increase with age, as was the case when comparing the 14 yr old participants to the 18 yr olds (p=0.08) and 19 yr olds (p=0.05) which yielded a significant difference in body mass indices between these age groups. However, since body mass index is a heaviness indicator, rather than a body composition predictor, it was necessary to compare the body fat percentages and body densities of the different age groups as well. No significant difference was noted between the age groups.

5.2.1 Body Density, % body fat and body mass index compared between the various age groups

No statistically significant differences were noted between the various age groups and the variables body density (p=0.19)(Figure 4.4) and % body fat (p=0.19)(Figure 4.5). There was a significant difference in BMI between age groups 18 (p=0.08) and 19 (p=0.05) when compared with age group 14 (Figure 4.6). Body Mass Index in boys increases between age 8 yrs and 19 yrs (National Health Statistics Report U.S. 1999-2004).

Heyward, and Stolarczyk, (1996) reported an average body density of 1.082-1.113g/ml for white males. With body density being a measurement that expresses total body mass relative to body volume, our u/20 surfers had an average body density of 1.08g/ml. Based on the findings that body fat % did not affect the final ranking, it is recommended that the % body fat is just an estimate, and should be utilized to track progress in training over time. It does provide a baseline for this purpose.

5.2.2 Body density, % body fat and BMI grouped by rank

When comparing surfers ranked in the top 12 compared to the rest, no significant difference between % body fat (p=0.13) (Figure 4.8), or body density (p =0.14) (Figure 4.7) was demonstrated. The average % body fat of 8.55% ± 1.55% was above the minimum where which Melzer and Fuller, (2008) felt surfers would be at risk of increasing fatigue, increasing risk of infection and cold intolerance. The body fat % of the u/20 surfers was not high which differs from Mendez-Villaneuva and Bishop (2005). This is most likely due to wet suit designs. The finding that body fat % did not influence the final ranking differs from Barlow et al., (2012) who reported that body fat % correlated with the rating of surfer ability. Lima et al., (2011) in a study of seven elite female Brazilian surfers, using a three site formula (Jackson and Pollock, 1985) report a % body fat of 10.00% ± 3.62%. Reilley et al., (2007) in a study of 22 male beach lifeguards in the United Kingdom found an average % body fat of 15.2 %.

However, there was a significant difference between rank and BMI (Figure 4.9) (Table 4.2). Indirectly translating higher body density (total body mass relative to body volume) into greater force output, with better paddling and surfing power, body density did not influence the rankings (Figure 4.7). Melzer and Fuller, (2008) regard power to weight ratio as an important determinant of performance. The ratio of muscle to fat (lean body mass) determines the maximum force output. With no statistically significant differences between body fat percentages and body densities, the increased BMI in surfers with higher rankings (Figure 4.9) could indicate increased muscle mass, more stability and better control on the waves.

The National Center for Health Statistics in South Africa reports the average 16 yr white male to weigh 63 kg, with a height of 1.73 m and BMI of 21.07 kg/m^2. The average 18 yr white male weighs 70 kg, at 1.77 m and BMI of 22.36 kg/m^2. When assessing the results of these adolescent surfers, the normal growth patterns must be considered for height and mass. The average age of our surfers was 16.3 ± 1.86 yrs.

Mendez-Villanueva et al., (2005) reported the BMI of the elite surfers was 22.63 kg/m^2, and the BMI of the regional surfers 23.23 kg/m^2. During the 2011 Jeffreys Bay WCT contest in South Africa, 34 professional surfers were reported to have an average BMI of 23.51 kg/m^2 (contest profiles). Our u/20 surfers had a BMI average of 21.57 kg/m^2. These values suggest an ideal BMI for adult professional surfers to be 22.6 – 23.6 kg/m^2. Our higher ranked u/20 surfers were shown to have a higher BMI than the rest (Figure 4.9), unlike Mendez-Villanueva et al., (2005) who found a lower BMI in the better surfers. This discrepancy is due to the latter surfers being older with an average age of 27.5 ± 3.6 yrs. In addition, our u/20 surfers were most likely in their growth spurt which will result in increasing BMI between ages 8 to 19 yrs (Eston and Rielly, 2001).

5.2.3 Height, age and mass

The average age of the u/20 surfers assessed was 16.3 ± 1.86 yrs, and their average height 1,714 ± 0.06 m (Table 4.1). The average mass was 63.35 ± 7.62 kg, this compares with Lowden and Pateman, (1980) finding an average mass of 66.79 ± 7.2 kg and Loveless and Minahan (2010) finding an average mass 61.1 ± 9.2 kg. When plotting the u/20 surfers heights on the stature-for-age percentiles (Figure 2.2.2), 22 of the 39 surfers were below the 50th percentile, with 11 of those below the 25th percentile for stature. This confirmed the surfers to be of shorter stature, as reported by Mendez-Villanueva et al., (2005).

When comparing the surfers ranked in the top 12 against the rest, no significant differences were noted for the variables age ($p=<0.77$) and height ($p<0.79$) (Figure 4.11 and Figure 4.12). Expecting increasing age to translate into more years surfing experience and time spent on the water, it was shown that age did not influence rank (Figure 4.10).

Shorter surfers would have a lower center of gravity, with better stability and balance expected. Stability is inversely related to the height of the center of gravity above the base of support (the surfboard) (Hayes, 1982). However, no relationship was demonstrated between short stature and higher ranking (Figure 4.12). A possible explanation would be that the center of gravity is highly dependent on body position and changes substantially depending on the position of the limbs (Robertson et al., 2004).

The mere lifting of a hand can influence the position of the centre of gravity. It is extremely sensitive and therefore not just dependent on stature. Therefore, technique would play a profound role in the position of the centre of gravity and subsequently the position thereof in relation to the base of support (Robertson et al., 2004).

Loveless and Minahan, (2010) noted, in a study of 11 male surfers, average age 17.1 yrs, their average mass was 61.1 ±9.2 kg, and average height 1.71 ± 0.08 m. Their findings that competitive surfers are shorter and lighter than the average age matched sporting population was supported by the findings of Mendez-Villanueva et al., (2005). Their studies on older competitive surfers noted that elite surfers, average age 25.6 yrs had an average mass of 67 ± 4.3 kg, and average height of 1.72 ± 0.049 m. By comparison, their regional surfers, average age 26.5 yrs, had an average mass of 71.1 ± 2.6 kg and height of 1.74 ± 0.047 m. During the 2011 Jeffreys Bay WCT contest in South Africa, the 34 professional surfers were reported (from their contest profiles) to have an average age of 27.91 yrs, average height of 1.77 m, average mass of 74.06 kg. SSISA reported an average measurement for male national surfers, of 1.68 m, mass 58.5 kg for the u/16 surfers. The u/20 surfers had an average height of 1.74m and mass 64.8 kg. Rielly et al., (2006) in a study of 22 male beach lifeguards in the United Kingdom found an average age 24.4 ± 5.6 yrs, mass 80.9 ±10.8 kg, height 1.83m ±0.077 m. Barlow et al.,(2012) noted an average age of 15.61 yrs height 1.74 m and mass 63.27 Kg in junior national surfers.

The results confirm the findings of Mendez-Villanueva and Bishop, (2005) that elite surfers display specific size attributes in particular a lower height and body mass when compared with other matched aquatic athletes. These findings are also in agreement with Meltzer and Fuller, (2008) who stated that the athlete should choose a sport which suits their natural physique best recognizing that genetics is a major determinant of body fat and body shape. The finding that age did not influence final ranking (Figure 4.10) could possibly be due to the natural skill element of surfing.

5.2.4 Circumferences

With testing being conducted on the beach venue during the contest, variables such as upper body power output and VO_2 max were unable to be measured. Three circumferences were measured namely waist to hip ratio, chest to waist ratio and chest to hip ratio.

The average waist to hip ratio (WHR) was 0.84. When comparing the WHR of the top 12 surfers to the rest, there was no significant difference ($p=0.59$) (Figure 4.13). In the non-athletic person waist to hip ratio is used as a measure of body weight and body fat distribution on an individual. In this research the waist to hip ratio was used as a marker for increased lower body muscle mass and possibly a marker for lower body strength demands. A smaller waist to hip ratio could indicate a better response to lower body demands of surfing.

The average chest to waist ratio (CWR) was 1.20. When comparing the CWR of the top 12 surfers to the rest, there was no significant difference ($p<0.13$) (Figure 4.14). Although chest to waist ratio is a measure of the physique of an athlete, the researchers postulated that a higher chest to waist ratio could indicate a better response to the upper body demands of surfing. Sheppard et al.,(2012) report a strong association between relative (total kg lifted/ surfers mass) upper body pulling strength and sprint paddling ability in surfers. No relationship between final ranking and chest to waist ratio was demonstrated, although this variable is included in the forward stepwise discriminant analysis.

The average chest to hip ratio (CHR) of 38 surfers was 1.02. When comparing the CHR of the top 12 surfers to the rest, there was no significant difference ($p<0.69$). The researchers' expectation was that this ratio would be greater due to greater upper body demands (paddling) in surfing. The results show a consistent ratio throughout the various age groups. No substantive conclusions could be drawn from the CHR.

5.3 MENTAL SKILLS

The mental skills of the u/20 surfers are reported in Table 4.3. Self-confidence and commitment skills (foundation skills) scored the highest, with goal setting (foundation skill), activation (psychosomatic skill) and imagery (cognitive skill) next highest. The cognitive skills of mental practice and competition planning scored intermediate, with focusing (cognitive skill) and fear control (psychosomatic skill) scoring lower than 4.7 out of possible 7. The lowest perceived mental skills were stress reactions (psychosomatic skill) and refocusing (cognitive skill).

Comparing the surfers in the top 12 rankings with the rest (Table 4.5), they scored marginally higher in self-confidence, and lower in imagery, although there was no statistically significant relationship between the mental skills scores and the final rankings. This could be due to the surfers answering the questionnaire as perceived rather than actual mental skills. However, it is possible that the more successful surfers possess more refined mental skills than do the lower ranked surfers.

The expectation would be that these competitive surfers would show good commitment, high self-confidence and goal-setting. Travelling across South Africa to compete at 5 different contest venues requires high commitment and self-confidence. The commitment of these u/20 surfers is reflected in the fact that 14 of the 15 top ranked u/20 surfers in South Africa in 2010 were participants in this research in 2008.

The findings also are in agreement with Durand-Bush et al., (2001) who report that the 4 most important mental skills are goal-setting, self-confidence, commitment and focusing. Bota, (1993) reports similar important mental skills. It was expected that surfers in the top 12 rankings should have scored higher on refocusing and stress reactions, however this is in agreement with Orlick and Partington (1988) who reported that refocusing is an extremely important mental skill, but often the least practiced by athletes. Having scored high in competition planning (Figure 4.16), it was expected that those plans would help the u/20 surfers focus and refocus before and during the contest heats, as well as evaluate their performance after the heats (Orlick and Partington, 1988). However, it was found this was not the case. Martin, (2006) suggests that surfers must be able to focus, to screen out a mass of irrelevant internal and external information that detracts from their performance. External distractions include bad calls, poor performance and unfavorable surf conditions. Internal distractions include worries about failing and thinking about scores. Surfers must be performance focused, not outcome focused.

Activation, which includes self-talk, will assist in maximizing self-confidence and performance (Martin, 2006). Good self-belief while competing is an important discriminating factor between more or less successful competitors in a wide range of sports (Hardy et al., 1996). Noakes, (2011), when asked how does an athlete win, especially when the competitors are all of a similar standard, replied "*it is 100% genetic, 100% psychological*", but when it comes to the top 5, it is the athlete who chooses to win who will win. With there being no statistical difference when comparing the mental skills of the top 12 against the rest, it is probable that the will to win is an important factor.

Perhaps inability of the surfers to focus (being here and now) (Table 4.4) and refocus (the ability to quickly regain a positive and effective focus when faced with distractions) can be attributed to poor mental preparation and pre-competition routines, resulting in an inability to cope with distractions and unforeseen circumstances (Weinberg and Gould 2007). When truly focused, visual cues should result in arousal, a rapid response and less likely predisposal to injury. The low scores in stress reaction skills (Figure 4.16) (Table 4.3) can be attributed to the u/20 surfer's concerns about sponsorships, maintaining or improving his rankings or the threat of not being able to remain in the Series.

The researchers have learnt from this typology of mental skills that performance enhancement should include core mental skills before, during and after competition heats. It is possible to prevent negative and doubting thoughts through mental skills training (Martin, 2006). In the discriminant analysis (Table 4.6), seven mental skills are included in the 12 discriminant variables, suggesting that at competition level the deciding factor may well not be the surfing ability, but the ability to perform under stress (Thomen, 2009). Those seven mental skills were found to be significant when predicting whether a surfer could end the competitive season in the top 12. From the typology generated of mental skills profiles of u/20 surfers from a similar skill level, we note that certain mental skills are identified as important for performing at a higher level. These are the cognitive skills of focusing, refocusing and competition planning. The foundation skills of goal setting, self-confidence and commitment are also important.

Eloff et al., (2011) in a survey of mental skills in South African hockey players, reported the highest mean scores on Omsat 3 to be goal setting, self confidence and commitment. The poorer mental skills are likely to be least practiced mental skills.
Having a high degree of self-belief during the heat is critical to optimizing the technical and tactical performance of the surfer (Rushall, 1988). The skills of stress reaction, refocusing, focusing and fear control must be addressed. Mental skills training should be the foundation of each athlete's individual training regimen (Weinberg and Gould, 2007). The role of sharpening the mental acumen of athletes young and old continues to grow.

The researchers' expectation was that there should be a statistically significant difference when comparing the mental skills of the top 12 surfers against the rest. This study was not able to identify any difference. This could be due to several factors including some of the surfers not concentrating, answering the questionnaire according to perceived rather than actual mental skills or the OMSAT 3 being inappropriate when differentiating top surfers from the rest. Other mental skills questionnaires to be considered could be a mental toughness inventory, or concentration questionnaire. A sports personality questionnaire could also be considered. A follow up mental skills study of these surfers with personal interviews could clarify the reason for similar mental skills scores.

5.4 NUTRITION

There is a concern that young athletes have marginal and inadequate carbohydrate and energy intakes (Thompson, 1996), and a lack of knowledge of healthy nutritional practices (Felder et al., 1998). This study attempted to identify the foods and fluids readily available at the contest venues, as also the likes and dislikes of the surfers. The aim would be to provide dietary advice to improve endurance, reduce fatigue, aid recovery and improve mental performance. In this study the food intake of the u/20 surfers was not quantified preventing the researcher from comparing carbohydrate and confectionary intake with protein intake.

The favorite foods utilized by the U/20 surfers during contests included: (Figure. 4.19)

Sandwiches and bread rolls- a slice of white bread has 442 KJ (kilojoules)- cheeses (high in saturated fats, a good source of protein) , fast foods from Wimpy, Mc Donalds and Steers (a hamburger roll has 556 KJ) and red meats such as steaks, braai meats. Fish was only eaten by 2 of our surfers, chicken by 10, pasta by 6 and breakfast cereals by 19 surfers (Figure 4.19). The male surfers ingested more red meats (24 of 42 surfers), mainly in the middle and lower rankings.

A food not readily available at the contest venues was pizza, with 11 of 42 surfers listing pizza as one of their favorite foods. Although the slice size of pizza varies, a slice can provide 798 to 1134 KJ, or 27-28 grams carbohydrate. Frequently ingested fluids were cold drinks, milk shakes, fruit juices and water. Supplements use was acknowledged by 21 of 42 surfers. These were mostly multivitamins, with only 6 surfers using protein supplements (creatine, protein shakes). Only 3 surfers finishing in the top 12 acknowledged use of supplements, presumed to be a result of drug testing awareness. Surfing South Africa follows the South African Institute for Drug free Sport (SAIDS) guidelines as regards the use of banned substances in sport and all competitors who enter a SSA event thereby agree to submit to drug testing by an approved agency. Less utilized foods were energy bars, sausages, ham, fish, yoghurt and macaroni. Other high fat foods such as peanuts, waffles, chocolates and potato crisps were less popular. Vegetables were not a favorite food (½ a cup of average vegetables provides 161 KJ (low Glycemic Index). Cheese was the only high fat food consumed frequently (Figure. 4.19).

The top 12 surfers did ingest more eggs and potato fries. Potato fries (slap chips) have a high GI and fat rating, with 30 chips providing ±1550 KJ. The surfers in the top 12 consumed less cheeses and red meats. Their cereal and fruits intake was low. The researchers expectations were that the u/20 surfers during contests would follow a diet determined by the availability of the different food types. The results indicate that the u/20 surfers consumed readily available foods and fluids during contests with very little planning ahead. The u/20 surfers were naïve regarding pre-heat meals, top up snacks, fluid requirements and recovery meals.

To advise on nutritional strategies, the energy demands of the surfers must be considered, as also the nutritional content and function of the food. The u/20 surfers mean resting metabolic rate was calculated at 1770.14 Kcals/day (std deviation 158.06). Utilizing a PAL (physical activity level) of 1.8 for surfing, this would estimate an energy expenditure of 3186.25 Kcal/ day or 13.38 Mj/day for surfers. Dependent on the surf conditions and number of contest heats the surfer is required to surf on the day, a PAL of 2.1 would translate into an energy expenditure of 15.61 Mj/day. Meir et al., (1991) estimated energy expenditure in recreational surfers to be 13.372 Mj/day. Felder et al., (1998) estimated 10 Mj/day energy expenditure per in female surfers.

.

From our results of the 24 hour dietary recall the researcher can confirm that the venue determines the food and fluids available, influencing the food and fluid choices of the surfers. Based on the findings from this study, there seems to be a need to educate the surfers on more appropriate foods to ingest, such as cereals and fruits, which have a lower GI for sustained energy release and prolonged satiety. These low GI foods will not likely cause gastro - intestinal discomfort. Exceptions are weetbix and cornflakes, which are high GI cereals and watermelon a high GI fruit. They can be advised about low GI foods at breakfast, such as muesli, fat free yoghurt, provita, toast and energy bars. Between contest heats, readily available high GI sources can be sweets (jelly babies, lifesavers, marshmallows) corn flakes (790 Kj per cup), and energy drinks. Frequently used energy drinks were Red Bull (480Kj per 250ml), Play (822Kj per 440ml), USN Spike 500Kj per 250ml) and Monster (418Kj per 240ml). The average soft drink has 568 Kj per can, energade 600 Kj per bottle, powerade 625 Kj per bottle and lucozade 924 Kj per bottle. Appletiser and grapejuice are low GI fruit juices. Accepting that nutritional strategies must be individualized, the u/20 surfers could utilize more portable carbohydrates such as yoghurt, fruit and sports bars to overcome limited time and facilities available for food preparation, as also lack of appetite before contest heats.

The u/20 surfers need to be educated regarding nutrition and then find a combination of nutritional sources that will fit their taste, budget and training/competition schedules. Trying anything new during the competition stages is best avoided (Sports Dietitians Australia, 2007). An attempt should be made to manipulate their diet to improve endurance and aid recovery in the contest period. Out of contest dietary strategies should aim to improve mental performance and skills, reduce fatigue and, where necessary, alter body composition (muscle to fat ratio). The overall aim of nutritional strategies must be to maximize performance and minimize potential for injuries during training and contests (Brukner and Khan, 2007). Inadequate carbohydrate intake can result in fatigue, with a resultant higher risk of injury. Similarly, inadequate nutrition may increase the risk of injury due to its effect on recovery. Supplements are not required in well fed adolescents, and creatine supplementation is not recommended in surfers under 18. There are natural sources of creatine, namely meat, fish, chicken and biltong.

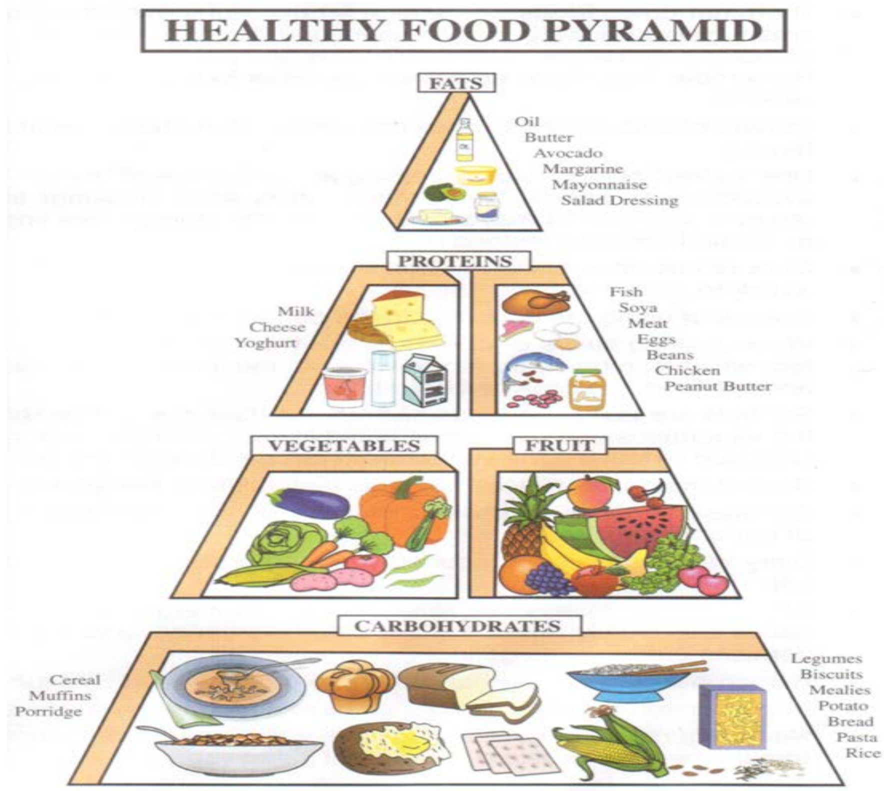


Figure 5.3.1 Healthy Food Pyramid (Bayer)

When comparing the surfers' dietary preferences with the healthy food pyramid, the surfers did utilize most of the listed foods and fluids in the pyramid. Although we are aware of the nutritional content of the foods and fluids ingested, we did not record exact amounts ingested. The pilot study demonstrated that the u/20 surfers had difficulty recalling the amounts of foodstuffs and fluid ingested. It would be impractical to advise the surfers as to the number of grams of each macro nutrient we recommend according to their weights as they spend their day on the beach and on most occasions they share basic accommodation at the contest venues.

5.5 DISCRIMINANT ANALYSIS

From this exploratory study we can therefore conclude that the variables BMI, imagery, mental orientation, self-confidence, chest to waist ratio (ratio 2), thigh skin fold, refocusing, focusing, height, fear control, mass and commitment are important variables when evaluating the overall performance of a surfer (Table 4.6). Comparing the 12 variables listed in the discriminant analysis (Table 4.6), we can correctly predict 87.5 % of the surfers in the top 12 rankings (Table 4.7). The surfers ending out of the top 12 can be correctly predicted 96.6 % of the time. This differs from Mendes-Villanueva, (2010) who concluded that competition outcomes are largely unpredictable. However, our research predictions are based on the results achieved during a series of 5 contests during 2008.

The forward stepwise discriminant analysis (Table 4.9) excludes six of the variables which were found not to be statistically significant in the final analysis when allocating a surfer to either the top 12 ranking, or a final ranking outside the top 12. Four mental skills (imagery, fear control, mental orientation and self-confidence), the chest to waist ratio of the surfers and their BMI are important variables when attempting to predict the probability of a surfer finishing this competitive surfing series in a higher ranking. Using these six variables only, predicting those finishing within the top 12 was only 55.6 % correct (Table 4.9). However, we could predict with 96.0% certainty those surfers who would finish the competition outside the top 12 (Table 4.9).

The 4 mental skills listed in the forward discriminant analysis can be described as follows:

- Imagery can positively enhance performance in sport. Imagery is used to visualize specific goals such as winning a particular contest and/or having a good performance. From the cognitive aspect imagery enhances performance. The function of imagery might be dependent on the individual athlete (Weinberg and Gould 2007).
- Fear control results from being afraid of failing and/or making mistakes
- Mental orientation allows athletes to feel more in control regardless of situational influences
- Self confidence is an important mental skill. The athlete in top rankings who chooses to win will win (Noakes 2011).

This study identifies the chest to waist ratio as being an important variable in the forward discriminant analysis. This is most likely the result of this ratio being indirectly related to paddling speed and upper body power output in surfers.

Another important variable identified as having an effect of the surfer was the body mass index . An increase in body mass index should result in better stability and postural control on the surf board.

CHAPTER 6

Conclusions and Recommendations

From the research conducted, the shorter stature of the u/20 surfers was confirmed, when plotted on the CDC stature –for- age percentile chart. This would allow greater stability, as stability is inversely related to the height of the center of gravity above the base of support (the surfboard). This is in agreement with the theory that the athlete chooses a sport which best suits their natural physique (Melzer and Fuller, 2008, Collins, 2009). The researcher could not confirm the previously reported higher % body fat in surfers. The u/20 surfers had a low % body fat as has been found to be beneficial in most non weight-making sports. The discriminant analyses confirmed that the mental environment is more important than the physical traits of the surfer, with refocusing and stress reaction skills being identified as skills poorly practiced and needing attention. The nutritional preferences of the surfers depended on the availability of the various foods and fluids. With an estimated daily energy expenditure of 13.38 to 15.61 Mj for the surfers, their in-contest food and fluid types were compatible with the Healthy Food Pyramid. They were naive when discussing pre, intra and post (recovery) heat meals. As with an elite contest in any professional sport, there is relatively little difference in the skills level of the top competitors (Martin, 2006). The researchers accept that a multitude of factors affect surfing performance, namely nutrition, sleep and rest, mental skills/attitude, genetic skills and training and equipment. Accepting that athletes chose a sport that suits their stature best, and that there is a genetic influence on skill, this research has attempted to provide avenues for surfers to perform at a higher level. Mental skills and nutrition have been identified as areas causing stress and holding the u/20 surfers back.

U/20 surfers are unlikely to follow set physical training programmes. They would rather just surf in different conditions and experiment with different equipment. Providing the necessary mental skills training and sound nutritional advice should not encroach on their surfing time. The general attitude of the u/20 surfers to focus their training load on water time, skill and technique is supported by Meltzer and Fuller (2008).

The 12 variable forward stepwise discriminant analysis (Table 4.6) can be utilized to advise the surfer as to his competitive potential at that time, and which areas of his training require further attention. The coaches and sponsors should also find this analysis to be of assistance in recognizing young surfers with potential. Although this analysis can be utilized in talent identification in surfing, it is not meant to predict competition outcomes as it is impractical to asses every surfer before a contest. The researcher also accepts that there are other influences determining the outcome of a contest. Coaches of competitive surfers wishing to succeed at a higher level should focus on BMI, imagery, mental orientation, self-confidence, fear control and chest/waist ratio. This research confirms that the mental environment is far more important than the physical traits of a competitive surfer. Mental skills training should be an important component of each surfer's individual training regimen. This must be complemented by a sound individualized nutritional plan during and between contests. Due to the waiting period allowed for suitable surfing conditions at surf contests- 3-4 days locally, 7-10 days internationally, the last day of the contest the surfer may be required to surf 3 or more heats. Inadequate recovery time may result in fatigue, loss of concentration and increasing risk of injury.

Advice to u/20 surfers is to get enough quality water time, in different surf conditions. Furthermore, they must focus on variables they can control, such as nutrition and mental toughness. They, together with their coaching staff, must identify their zone of optimal functioning to become an elite surfer. Performance is mind body connection (Noakes, 2011). When the surfer gets into the top rankings, it is he who chooses to win who will win.

Percentage body fat should be utilized to direct and measure the progress of the surfers exercise and nutritional programs. Standing alone, the % body fat has no predictive value for the surfers. Consideration must be given to utilizing air displacement (Bod Pod) to calculate body composition and resting metabolic rate in an attempt to standardize body fat estimations. Although underwater weighing is the gold standard when estimating body composition, it remains an expensive test.

Whilst conducting this research, the researchers were able to recommend the following based on observations made at the contests. Family and coaching staff can be reassured that there is adequate time to develop these young, competitive surfers, as the average age of the WCT surfers is 27 – 28 yrs. Furthermore, this allows enough time for the young surfer to adapt to any physical constraints. The u/20 competitive surfer, who requires home schooling due to undue and perhaps excessive surfing commitments, will likely be deprived of learning general life skills and partaking in team sports at school. Surfing in South Africa is not yet a profession. Those committed u/20 surfers are at risk of being left without life skills for life after competitive surfing.

Contest organisers should consider appointing a food provider who has access to the correct food and fluids required by the u/20 surfers at the contest, to provide adequate hydration, as also portable carbohydrates between heats, whilst waiting on the beach and a recovery drink or meal. Healthy catering is one of the five key health areas in promoting environments within sporting associations. The other areas are smoke free facilities, sun protection, responsible serving of alcohol and sports injury prevention (Dobbinson et al., 2006).

There was difficulty deciding whether the surfers answered the OMSAT questionnaire in accord with perceived or actual mental skills. Excessive selection of the middle values of the 7 point Likert scale was due to the greater tendency among the surfers to avoid extreme values. In this study, 26.88 % of answers were the two extreme values, namely strongly agree or strongly disagree. The absence of a statistically significant difference in mental skill between the top 12 surfers and the rest can be attributed to the fact that 27 of the top ranked 30 surfers were included in this analysis.

There were certain limitations to the u/20 study. These included the fact that the 4 best competition scores of each surfer counted towards his final ranking. There were surfers who were unable to contest 4 of the 5 contests due to other commitments (school, travelling expenses, illness or injury). Noting the years of surfing experience, as also the hours spent in practice could have been included. Mendez-Villaneuva and Bishop, (2005) found the surfers in his research group practiced 6 days per week.

Lowden and Pateman, (1980) in a study of 97 international surfers found they practiced for 5 days a week on average, for an average of 3.7 hours per day.

ADDENDUMS

Addendum 1

CONSENT TO PARTICIPATE IN RESEARCH

I have been asked to participate in a research study during my participation in the Billabong Junior Surfing Series 2008.

I have been informed about the study by Billabong SA

I may contact Dr. Fred Oosthuizen at 0823201229 at anytime if I have questions about the research.

I may contact the Secretariat of the Ethics Committee of the Faculty of Health Sciences UFS at 051-4052812,if I have any questions about my rights as a research subject.

My participation in this research is voluntary and I will not be penalised if I refuse to participate in this research or decide to terminate participation.

All information supplied by me will be treated as confidential and used solely for the purposes of research.

I can have a signed copy of this document if I so wish.

The research study, including the above mentioned has been explained to me. I understand what my involvement in the study means and I voluntary agree to participate.

Signed at on this day of 2008.

Participant Witness

Addendum 2

INFORMATION SHEET FOR PARTICIPANTS

“The research institution is the Division of Sport and Exercise Medicine, University of Free State, South Africa. The main researcher is Dr. Fred Oosthuizen, assisted by a Dietitian, Sport Scientist and Medical Practitioner

The aim of the study is to improve the performance of South African surfers by promoting scientifically sound mental, nutritional and physical guidelines for pre contest training.

There will be no financial incentive to participate in the research, however each participant will receive the results their personal assessments at no cost.

Further research is needed in all areas of surfing performance in order to gain an understanding of the sport and eventually bring surfing to the next level of performance. Surfboard riding has experienced a boom in participants and media attention over the last decade at both recreational and competitive level. However despite its increasing global audience, little is known about physiological and other factors relating to surfing performances.

Your participation is important to the success of the study. The interviews will be conducted in English/Afrikaans. The information remains confidential.

Those choosing not to participate will not be prejudiced in any way.

The findings will be available in 2009 on the Billabong SA website.

For further information about the study, contact Dr. Fred Oosthuizen at 0823201229.

We thank you for your participation

Addendum 3

STANDARDIZED DESCRIPTION OF SKINFOLD SITES AND PROCEDURES

Skinfold site

Abdominal	Vertical fold; 2 cm to the right side of the umbilicus
Triceps	Vertical fold; on the posterior midline of the upper arm, halfway between the acromion and olecranon processes with the arm held freely to the side of the body
Chest/Pectoral	Diagonal fold; one-half the distance between the anterior axillary line and the nipple (men), or one-third of the distance between the anterior axillary line and the nipple (women)
Midaxillary	Vertical fold; on the midaxillary line at the level of the xiphoid process of the sternum. An alternate method is a horizontal fold taken at the level of the xiphoid/sternal border in the midaxillary line.
Subscapular	Diagonal fold (at a 45-degree angle); 1 to 2 cm below the inferior angle of the scapula
Suprailiac	Diagonal fold in line with the natural angle of the iliac crest taken in the anterior axillary line immediately superior to the iliac crest
Thigh	Vertical fold; on the anterior midline of the thigh, midway between the proximal border of the patella and the inguinal crease (hip)

Procedures

- All measurements should be made on the right side of the body with the subject standing upright
- Caliper should be placed directly on the skin surface, 1 cm away from the thumb and finger, perpendicular to the skinfold, and halfway between the crest and the base of the fold
- Pinch should be maintained while reading the caliper
- Wait 1 to 2 seconds (not longer) before reading caliper
- Take duplicate measures at each site and retest if duplicate measurements are not within 1 to 2 mm
- Rotate through measurements sites or allow time for skin to regain normal texture and thickness

Addendum 4

GENERALIZED SKINFOLD EQUATIONS FOR MEN

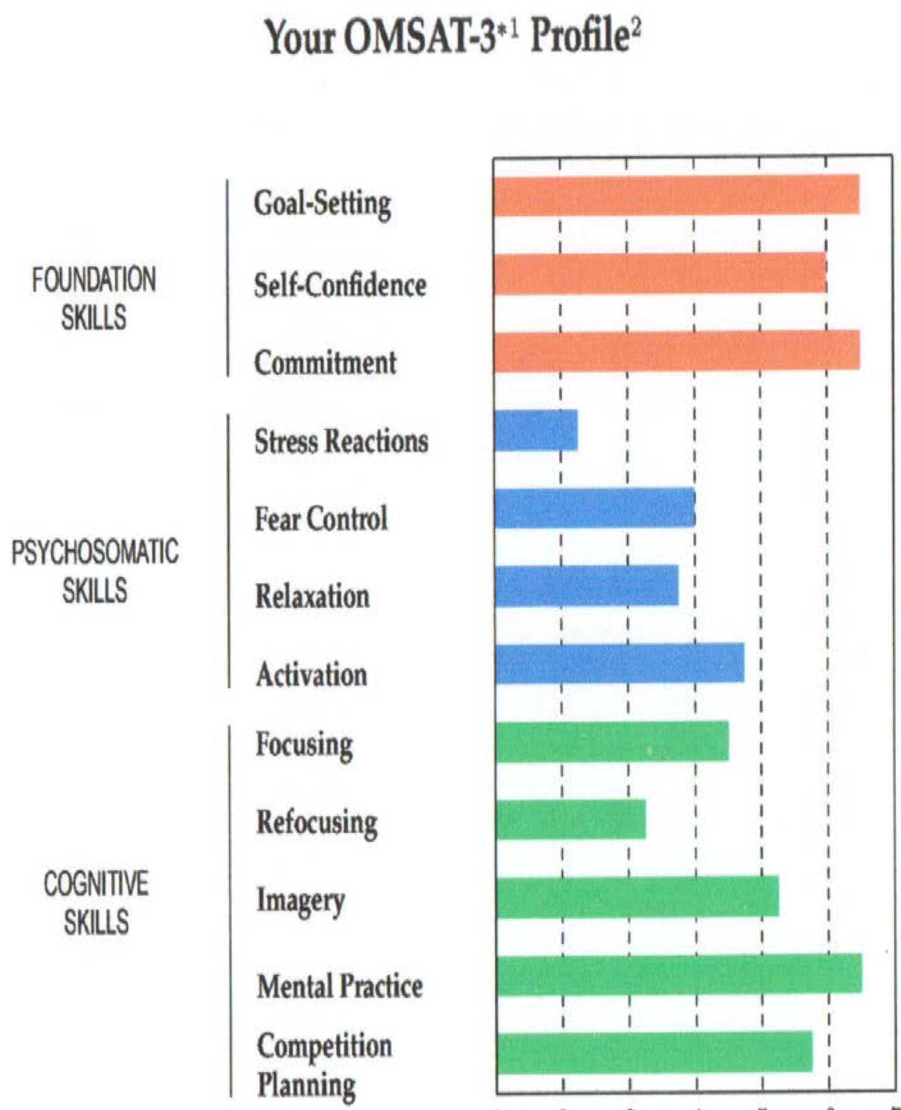
Seven-Site Formula (chest, midaxillary, triceps, subscapular, abdomen, suprailiac, thigh)

Body density = 1.112 – 0.00043499 (sum of seven skinfolds) + 0.00000055 (sum of seven skinfolds) ^{2} - 0.00028826 (age)

[SEE 0.008 or ~ 3.5% fat]

Addendum 5

EXAMPLE OF OMSAT-3 PROFILE



Addendum 6

Food and Fluid Intake Chart

Participant No:		
Date:		
Day of the contest:		
Is this a typical day for you:		

Time	Description & Preparation	Quantity
	Before Breakfast	
	Breakfast	
	Mid Morning Break	
	Lunch	
	Mid Afternoon Break	
	Dinner	
	After Dinner	

Addendum 7

Physical Measurements		
		Results
Venue:		
Surfer Name:		
Date:		
Sex:		
Position on Billabong 2008:		
BP:		
Weight:	Pre contest heat	
	Post contest heat	
Height		
BMI		
%Body fat:		
Waist to hip ratio		
Chest circumference		

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