
**UNIVERSITI PUTRA MALAYSIA**

***COMPARISON OF MILK, SPORTS DRINK AND WATER IN REHYDRATING RUGBY PLAYERS***

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# COMPARISON OF MILK, SPORTS DRINK AND WATER IN REHYDRATING RUGBY PLAYERS

By

**PATMAVATHY ALAGAPPAN**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science**

**June 2016**

**DEDICATED**

To

My beloved husband –
Saravanan Mariappan
for his unconditional love and support

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

**COMPARISON OF MILK, SPORTS DRINK AND WATER IN REHYDARTING RUGBY PLAYERS**

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**June 2016**

**Chairman : Kok Lian Yee, PhD**
**Faculty : Educational Studies**

This study was carried out to assess the effectiveness of milk (M), sodium added milk (Na+M), sports drink (SD) and water (W) for restoring fluid balance after exercise-induced dehydration among 25 UPM rugby players. It also compared the after-effects of consuming all these drinks after exercise-induced dehydration. A randomized crossover counterbalanced designed was utilized to compare the after-effects of consuming the four previously mentioned fluids after running on a threadmill intermittently in a hot and humid environment to lose 1.7 $\pm$ 0.1% of body mass (BM). Drinking commenced 20 min after the end of exercise and participants drank M, Na+M, SD, or W equivalent to 150% of their BM lost. Urine samples were collected to assess fluid balance. Participants were also asked to rate the after-effects experienced. Urine excretion over the recovery period did not change much during the M and Na+M trials whereas there was a marked increase in output between 1h and 2h after drinking water and sports drink. Cumulative urine output was significantly less ($p$ = 0.0001) after the consumption of M (817.35 $\pm$ 327.16 ml) and Na+M (642.78 $\pm$ 316.30 ml) compared to W (1410.04 $\pm$ 525.25 ml) and SD (1162.70 $\pm$ 378.92 ml). Subjects remained in net positive fluid balance (euhydrated) throughout the recovery period after drinking M and Na+M but returned to net negative fluid balance 1h after drinking the other drinks; SD and W. However, participants experienced more stomach pain/discomfort and diarrhoea after M (48%) and Na+M (68%) consumption, while the consumption of SD and W did not seem to induce diarrhoea. The results suggest that sports drinks may be a more effective post-exercise rehydration drink for Asian athletes as the higher frequency of lactose intolerance after milk intake may affect the state of fluid balance. Sodium added milk can be considered for use after exercise by athletes accustomed to drinking milk or for those who are able to tolerate lactose intake.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PERBANDINGAN ANTARA SUSU, MINUMAN SUKAN DAN AIR DALAM PENGHIDRATAN PEMAIN RAGBI**

Oleh

**PATMAVATHY ALAGAPPAN**

**Jun 2016**

**Pengerusi : Kok Lian Yee, PhD**
**Fakulti : Pengajian Pendidikan**

Kajian ini telah dijalankan untuk menguji keberkesanan susu (M), susu yang dicampur natrium (Na+M), minuman sukan (SD) dan air (W) untuk mengembalikan keseimbangan cecair dalam badan selepas dehidrasi yang disebabkan oleh senaman di kalangan 25 orang pemain ragbi UPM. Kajian ini juga bertujuan membandingkan kesan akhir akibat pengambilan semua empat jenis minuman ini pada akhir kajian. Satu kajian berbentuk 'randomized crossover counterbalance' telah digunakan untuk membandingkan kesan akhir selepas pengambilan minuman kajian. Peserta kajian berlari atas '*treadmill*' dalam keadaan panas dan lembab untuk mengurangkan 1.7 $\pm$ 0.1% daripada berat badan (BM). Minuman diberikan 20 minit selepas sesi senaman berakhir. Peserta kajian, menggantikan cecair badan yang hilang dalam bentuk peluh semasa senaman tadi dengan meminum dalam sususan rawak, M, Na+M, SD atau W. Kuantiti minuman yang diminum adalah bersamaan dengan 150% daripada BM yang telah berkurang akibat perpeluhan semasa senaman. Air kencing dikutip untuk menguji keseimbangan cecair badan. Peserta juga diminta mengisi soal selidik untuk menganalisis kesan akibat pengambilan minuman kajian. Tiada perbezaan yang ketara dalam pengeluaran air kencing dalam tempoh pemulihan untuk minuman M dan Na+M, manakala kelihatan peningkatan yang ketara dalam pengeluaran air kencing antara 1h dan 2h selepas minum air dan minuman sukan. Pengeluaran air kencing secara kumulatif berkurang secara signifikan (p=0.0001) selepas minum minuman M (817.35 $\pm$ 327.16 ml) dan Na + M (642.78 $\pm$ 316.30 ml) berbanding dengan W (1410.04 $\pm$ 525.25 ml) dan SD (1162.70 $\pm$ 378.92 ml). Keseimbangan cecair badan peserta kekal dalam keadaan positif ('*euhydrated*') sepanjang tempoh pemulihan selepas minum M dan Na+M tetapi kembali negatif pada 1h selepas minum SD dan W. Walau bagaimanapun, peserta mengalami lebih sakit perut dan cirit-birit selepas pengambilan M (48%) dan Na+M (68%), manakala pengambilan SD dan W tidak memberikan apa-apa kesan negatif. Keputusan kajian ini menyarankan bahawa minuman sukan lebih efektif selepas bersenam atau bersukan untuk atlet Asia yang mempunyai kadar alahan laktosa yang tinggi (kerap mengalami cirit-birit akibat

ketidakupayaan untuk menghadamkan gula susu atau laktosa). Kekerapan cirit-birit ini akan memberikan kesan negatif kepada keseimbangan cecair badan. Susu yang dicampur natrium boleh dipertimbangkan untuk kegunaan oleh atlet yang biasa minum susu dan tidak mempunyai alahan laktosa.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the Degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date:

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I hereby confirm that:

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**Declaration by Members of Supervisory Committee**

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____
Name of Chairman of Supervisory Committee: Dr. Kok Lian Yee

Signature: _____
Name of Member of Supervisory Committee: Associate Professor Dr. Hazizi Bin Abu Saad

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| | |
|---|---|
| M | Low-fat Milk |
| Na+M | Sodium added Low-fat Milk |
| SD | Sports Drink |
| W | Water |
| NaCl | Sodium Chloride |
| Na | Sodium |
| K | Potassium |
| VO2 max | Maximal Oxygen Uptake |
| BM | Body Mass |
| BW | Body Weight |
| TWI | Total Water Intake |
| DEH | Dehydration without Thirst |
| EUH | Euhydration without Thirst |
| USG | Urine Specific Gravity |
| IV | Independent variable |
| DV | Dependent variable |
| ANOVA | Analysis of Variance |
| MOE | Ministry of Health |
| MOH | Ministry of Education |
| MANS | Malaysian Adults Nutrition Survey |
| NATA | National Athletic Trainers' Association of America |
| ACSM | Malaysian Adults Nutrition Survey |
| UPM | Malaysian Putra University (Universiti Putra Malaysia) |
| MASUM | Malaysian Universities Sports Council Games (Majlis Sukan Universiti Malaya) |
| SUKIPT | Inaugural Malaysian Institutions of Higher Learning Games (Sukan Institut Pengajian Tinggi) |

# CHAPTER 1

# INTRODUCTION

## Background

The average daytime temperature and relative humidity in Malaysia range between 29-31°C and 70-90% respectively. However, despite these daunting statistics, Malaysians participate in a wide range of sports activities both for recreational purposes and competition. Singh (2005) suggested that participants in sports activities particularly from areas of hot and humid climate conditions need to give higher attention to hydration. Hydration is defined as the process of replacing the loss of body fluids to achieve water balance (McArdle, 2010). Proper hydration is an essential requirement for good health and life. Fluids sustain the body's many vital chemical reactions and regulate bodily functions (Greenwood, 2008). A study by Cheuvront, Carter & Sawka (2003) indicated that water is necessary to keep the body fluids in the right balance for the biochemical reactions of life and physiological functions.

Water constitutes 50-70% of the adult body and performs various physiological functions vital to life. It is the principal medium in which minerals, nutrients, gases and enzymes are dissolved. The extracellular water bathing the cells serves as the medium for the transportation of nutrients and oxygen to the cells and for removing waste from the cells, which will then be eliminated by the liver and the kidneys (Greenwood, 2008). Water also plays a big role in the regulation of body temperature. The excess heat in the body is excised by evaporation through sweat from the skin surface. When the body becomes too heated, this evaporation helps reduce heat and regulate temperature. Sweating is most effective in stopping the body from overheating and in cooling the body down. The human body needs plenty of water when exercising to help dissipate the heat generated by vigorous exercise through the sweat glands to the skin surface as sweat (McArdle, 2010).

The hot and humid climate in Malaysia is not favourable in relation to optimal performance sports, especially in aspects of prolonged performances, continuous exercises of aerobics, or irregular activities with high-intensity (Singh, 2005). The hotter the environment, the greater the amount of fluid loss that will occur in the body. This excessive loss of fluid (dehydration) can affect health adversely. This is because inadequate hydration slows the digestive procedure and chronic dehydration causes constipation. Dehydration also reduces cardiac productivity which leads to an increase in heart rate and fall in blood pressure. As there is reduction in blood volume and increase in body temperature, more pressure is put in the heart, lungs and circulatory system. This causes the heart to pump harder curtailing exercise efficiency and sports performance (McArdle, 2010). In effect, poor hydration has a negative influence on athletes' performance.

The influence of dehydration on athletic performance has been studied numerous times (Goulet, 2012; Coyle, 2004; Barr, 1999). It has been noted that dehydration via sweat-induction is able to harm physiological functions and training performance in training (Cheuvront, Carter & Sawka, 2003; Coyle, 2004). A decrease of 2% in body weight during exercise may decrease performance (Coyle, 2004), as well as weaken the capability to focus (Wilmore, 2008). Moreover, a reduction of over 2% weight in body because of dehydration can influence the brain's functioning abilities and harm short-term memory (McArdle, 2010). Progressive dehydration caused by prolonged exercises also impairs performance. It is not possible to stay fully hydrated during training (Shirreffs et al., 2005), and athletes should try to minimise body fluid losses. Dehydration needs to be controlled and body fluid losses need to be replaced so that the body can remain cool to allow cell reactions to continue to work well (McArdle, 2010).

To avoid dehydration, athletes need to start the training session or competition fully hydrated, by drinking water during and after training sessions or competitions. Fluid strategies are essential to maintain proper fluid balance during training and exercising in hot and humid environment (McArdle, 2010). This is done by consuming certain fluid before training, during training and after training. Hyper hydration or "fluid overloading" seems like a good strategy for athletes who compete in events involving ultra-endurance and in activities where there are limited opportunity to drink, or that occur in hot and humid circumstances (Bean, 2003). According to Singh (2005), 'loading up' with fluid before an event or training augments total body water, enlarges plasma volume, and boosts performance in the following training session. Water intake throughout long-lasting training is efficient in recuperating performance and in slowing down the inception of fatigue that takes place during training in heated conditions (Below et al., 1995; Montain & Coyle, 1992; Sawka, 1992). Optimal performance can be achieved if at least 80% of sweat lost during training is replaced (Montain & Coyle, 1992). However, *ad libitum* fluid ingestion in training does not completely avert a fluid shortage. Broad, Burke, Cox, Heeley & Riley (1996) deduced that athletes only reinstate around 30 - 70% of the loss of fluids acquired throughout training. Post-exercise restitution of the fluid balance can help minimise this condition. Substitution of liquid and losses of electrolyte in the post-exercise epoch is of huge significance in order to maintain the exercise capacity especially when there is repeated training (Singh, 2005). It is somewhat easier to restore sweat losses when there is no frequent repetition of exercise (Casa et al., 2000) which means that more attention is needed for fluid restoration when the exercise is repeated. Thus, post-exercise rehydration has been widely examined in recent 15 years (Shirreffs, Armstrong & Cheuvront, 2004).

According to Shepherd (2011) fluid balance can be assessed using three elements. There are body weight and urine output, clinical assessment, review of fluid balance charts and blood chemistry. In this study urine volume is chosen as a good indicator for fluid balance as suggested by Shireffs (2007). Nevertheless, other than the reinstatement of balance in fluid, the quantity of the drink taken is also a crucial feature in the process of rehydration. Rehydration following training necessitates replacement of electrolytes, primarily sodium that was depleted via sweat (Maughan & Leiper, 1995; Shirreffs & Maughan, 1998; Ray et al., 1998). The potassium accumulation in

the ingested solution could assist the reinstatement of fluid in the body subsequent to exercise-induced dehydration. Potassium would augment the alternative of intracellular water following exercise and thus promote rehydration (Nielsen, Sjogaad, Ugelvig, Knudsen & Dohlman, 1986; Yawata, 1990; Maughan, Owen, Shirreffs & Leiper, 1994).

Water is the fluid of choice for many. Water is a commonly consumed drink as it is stated by athletes. It is usually the preferred consumed recovery drink by mutually endurance as well as non-endurance athletes (Amy Johnson, 2007). For low short duration intensity exercises, water is substantial. If an individual run within an hour, water is the best consumption before and after run (Megan Ware, 2014). Although water is also the optimum fluid for ingestion in endurance exercises, the addition of substrate and electrolytes will boost its effects (Shirrefs, 2003). For in excess of an hour of high concentration and endurance sports, more than an hour, a drink inclusive of carbohydrate and electrolytes is more efficient compared to water (Megan Ware, 2014). The intake of plain water subsequent to exercise or training causes a decrease in plasma osmolality and concentration of sodium. This however, stimulates the production of urine and lessens the reason to drink. Eventually, this will delay the rehydration process (Nose, Mack, Shi & Nadel, 1988a). As significant electrolytes such as sodium and potassium are lost in sweat, replacement of minerals remains crucial (Gilson et al., 2009).

As a better alternative, sports drink can ideally fill the gaps in water as it is formulated with the right amount of substrate and electrolytes needed by athletes (Shireffs, 2003). The majority of sports drinks contain carbohydrate and electrolytes, mainly sodium in right amounts to stimulate rapid fluid absorption, to supply carbohydrate as a substrate for use during exercise, to speed rehydration, to reduce the physiological stress of exercise, and to promote recovery after exercise (Shireffs, 2003). Sports drinks also demonstrate that it is more palatable than plain water, thus promoting consumption of greater volume of liquid after exercise (Shireffs, 2003). However, sports drinks are acidic as they may damage teeth causing tooth decay. Furthermore, there are few situations where high sugar concentrations in sports drinks cause gastrointestinal distress (Shireffs, 2003). With this concern, the researcher intended adopting drink that can be commonly found in the home, like milk as a post exercise rehydration drink rather than using experimental solutions prepared in the laboratory.

Apart from water and sports drinks, there has been an increasing interest in milk as a sort of fitness and post-exercise beverage. Researchers are commencing to document the numerous ways milk is capable of benefiting vigorous people based on the National Athletic Trainer's Association of America (NATA), solution of rehydration should contain water, carbohydrates and electrolytes. This adheres to the nutrition profile of milk (Casa et al., 2000). Milk contains protein, carbohydrates, fluids and electrolytes comparable to some commercial carbohydrate electrolyte drinks. In fact, it offers a different advantage due to its high water content (Casa et al., 2000). Milk represents a very functional, cost effective and nutrient dense beverage choice for individuals who

partake in exercise, compared to traditional sport drinks. To conclude, milk is inherently a hydration beverage.

## Statement of Problem

Many individuals who participate in sports and exercise suffer some form of dehydration, based on the intensity of training, duration of training, surrounding temperature and humidity, and the individual's body chemistry (Bean, 2003). As dehydration can have an adverse impact on performance, it is essential to rehydrate in preparation for any subsequent exercise in order to help maximise one's capacity (Coyle, 2004). Thus, there is a need to find the best fluid to consume after exercise to rehydrate the body in hot and humid conditions.

Most works in the area of rehydration are narrowed towards the employment of experimental solutions primed in a laboratory. Milk, which supplies necessary nutrients in a suitable, reasonable package, is something most people already have. Milk is an effectual fluid for post-exercise, based on its extensive content of electrolyte, existence of carbohydrate in a concentration parallel to various well known accessible drinks influenced with carbohydrate-electrolyte, micronutrients, as well as protein (Watson, Love, Maughan & Shirreffs, 2008). However, preceding investigations utilising milk as a post-exercise rehydration drink is limited. (Shirreffs, Watson & Maughan, 2007; Watson, Love, Maughan & Shirreffs, 2008).

In Malaysia, thus far, the potential role of milk in assisting post-exercise rehydration has never been reputable. Previous rehydration studies in Malaysia focused on young coconut water, young coconut water added with sodium, plain water and sports drink as post-exercise rehydration drinks (Saat, Singh, Sirisinghe & Nawawi, 2002; Ismail, Singh & Sirisinghe, 2007). Furthermore, previous research on post-exercise rehydration drinks have mostly utilised physically active volunteers as subjects (Watson, Love, Maughan & Shirreffs, 2008; Shirreffs, Watson & Maughan, 2007; Ismail, Singh & Sirisinghe, 2007; Saat, Singh, Sirisinghe & Nawawi, 2002), rather than athletic populations. Although there may not be notable differences in rehydration rates between sedentary and athletic populations it would be useful to utilise athletes as the data may shed some light on whether there are differences between athletes and non-athletes. Using athletes would be better in rehydration research as they participate in vigorous exercise that cause a lot of energy usage which leads to higher levels of dehydration, making the investigation more pertinent. Also it is imperative for athletes to be well-hydrated in the pre, during and post exercise, as dehydration can cause inefficiency in performance and also can amplify the danger of heat illness. Therefore in this study, an attempt has been made to examine milk's effectiveness in restoring fluid balance in athletes.

## Research Objectives

Every research should have some objectives. The purpose of formulating objectives is to indicate the focus of the study. It should indicate exactly what the investigator intends to do, including how data are to be collected or what is observed and the setting of the study. The objectives should be specific but it may be more or less comprehensive (Ranjit Kumar, 2011).

The study comes with the purpose of investigating the effectiveness of low-fat milk for reinstating fluid balance following mild exercise-induced dehydration in hot and humid conditions. Specifically the objective of this study was to compare how effective low-fat milk, sodium added low-fat milk, sports drink and plain water in rehydrating UPM rugby players.

## Research Question and Hypothesis

The research question and null hypothesis for this study were constructed based on the research objective. They were formed as a prediction to give a possible explanation to the experimental results before further testing.

The research question and null hypothesis formed for this study was:

1. Is there any significant differences in urine volume excretion after consuming milk, sodium added milk, sports drink and water in UPM rugby players?

**$H_0$ 1:** There is no significant difference in urine volume excretion after consuming milk, sodium added milk, sports drink and water in UPM rugby players. **($H_0$ 1:** $\mu$Milk = $\mu$Milk+Na = $\mu$Sports drink = $\mu$Water = 0)

2. Is there any significant differences in the after-effects occurred after consuming milk, sodium added milk, sports drink and water in UPM rugby players?

**$H_0$ 2:** There is no significant difference in the after-effects occurred after consuming milk, sodium added milk, sports drink and water in UPM rugby players. **($H_0$ 2:** $\mu$Milk = $\mu$Milk+Na = $\mu$Sports drink = $\mu$Water = 0)

## Significance of Study

Post-training rehydration has been integrated as a part of sports nutrition for many years by coaches and trainers to improve performance in sports. To further optimize the benefits of post-training rehydration, the composition of the drink consumed after

exercise has been given priority to achieve the desired goal. Milk has been suggested as a potential post-exercise drink due to its high electrolyte and water content, and having a similar concentration of carbohydrate to sports drinks. This study may be able to produce much needed empirical evidence in the findings. These evidences and insights may be used as a basis for formulating strategies to improve performance in sports, the quality of life and overall wellness.

Although milk has been identified in this research as the potential post exercise drink to restore hydration in hot and humid conditions, there are some doubts about the acceptance of milk as a post-exercise drink by Asian population, who possess some form of lactose intolerance. The finding of this study may be able to indicate to what extent low-fat milk will restore fluid balance following mild exercise-induced rehydration in hot and humid condition for team sport athletes, especially those from the Asian population. Thus, this study may help the coaches and trainers to assess the benefits and risks involved in consuming low-fat milk as a post-exercise drink. The result of this study may also provide direction to generate new framework and hypotheses for further research on related topics.

## Limitations and Delimitations

Whilst pursuing a dissertation, it is vital for the researcher to encourage the reader of the impending impact of the study. This brings about a significance in clarifying the limitations and delimitations of the study (Simon, 2011). Limitations are the obstacles faced by the researcher ahead of his/her control. Researchers must clarify on dealing with the limitations or shortcomings and its effect on the outcome of the study. The delimitations are restrictions that are set by the researcher in order to manage the assortment of a study (Ellis & Levy, 2009). Delimiting factors include the alternative of objectives, the research questions, variables of interest and the population chosen (Simon, 2011).

This research must take into consideration that performance in sports is the outcome of multiple factors. Even with acknowledgement of limitations, it is highly impossible to manage and evaluate the net impact of post-exercise rehydration drinks on sports performance. The researcher realises there are some limitations in this study that may have affected the study and have taken steps to control those limitations. Additionally, a few delimitations were imposed to maintain the scope of investigation within limits.

The first delimitation involved the requirement that participants in this investigation avoid strenuous exercise 24 hours before each experimental trial. Researcher has taken into account participants' training and competition schedules prior to planning the schedule of experimental trials. However, participants in this investigation were athletes who practiced rugby three to four sessions a week and took part in tournaments throughout the experimental period. These training sessions and tournaments may have

had some influence on the outcome of results if it falls one day before the experimental trial. It is assumed that strenuous exercise was avoided 24 hours before each trial.

Secondly, honesty from all the participants was necessary and important with regards to maintaining their usual lifestyle, and they were prohibited from alcohol consumption. Alcoholic beverages have a diuretic effect and this may have a detrimental impact on hydration depending on the amount consumed (Wilmore, 2008). Also, it was assumed that the athletes involved in the study were physically healthy and were practicing similar dietary practices one day before participating in every experimental trial. They were asked to keep dietary records, and these records were checked by the researcher to monitor that no drastic changes in diet had occurred throughout the experimental period.

This is followed by an assumption by the researcher which involves sweat rate. Sweat rate refers to the loss in fluid, primarily through sweat. It is also the amount of fluid that should be consumed each hour while exercising to stay well hydrated and continue performing well. The average sweat rate for a healthy person is typically 1 - 1.5 *l*/hr during exercise (McArdle, 2010). However, sweat rates differ among individuals even under similar exercise conditions. Size of body, gender, intensity of exercise, environmental circumstances, the quantity of clothing worn, the accuracy in aerobic fitness and the acclimation status of the athlete will all manipulate the rate of sweat (Bean, 2003). Additionally, there are average sweat rates for various types of sports ranging from 0.5 - 2.5 *l*/hr (Casa, 2000). As this study utilises only athletes from one sport, it is assumed that all participants had a sweat rate that was normal for a team sport athlete, and was similar for all participants.

To make this study more workable and easier to control, a few more delimitations were set by the researcher. Homogeneity was achieved by selecting only male participants (rugby players of UPM) with similar body weight and age. All participants were tested with the bleep test to ensure a minimal level of 8 (VO2 max at least 40 ml/kg/min). All participants were elite level rugby players [top 5 finishes in Malaysian Universities Sports Council Games, MASUM (*Majlis Sukan Universiti Malaysia*) and Inaugural Malaysian Institutions of Higher Learning Games, SUKIPT (*Sukan Institut Pengajian Tinggi*)]. They could complete the entire protocol (running on the treadmill till they lost approximately 1.7% of their body weight) of experimental trial.

As for measuring the temperature and humidity, a climate chamber was not available in UPM. However, exercising in pure laboratory settings may not resemble transactions in real training or competition. The researcher monitored the temperature and humidity levels throughout the experiment period using a device called Heat Stroke Checker (WBGT-103, KEM, Japan) (hand-held type meter which displays surrounding thermal conditions). Data was collected within a temperature range of 32-35°C and a relative humidity range of 53-56% during all experimental sessions.

Lastly, individuals with known lactose intolerant were excluded. Lactose intolerance occurs when the small intestines lack the enzyme lactase, which is necessary to digest the lactose (McArdle, 2010). Lactose intolerance may cause individuals to experience symptoms of gas, bloating, diarrhoea and stomach upset when eating lactose-containing foods (Wilmore, 2008). Thus, the participants who experience these symptoms after consuming milk or milk products were excluded from this study.

## Definition of Terms

The variables in this study need to be defined conceptually/theoretically and/or operationally. Operational definitions explain the observable characteristics which are being measured in this study. The terms that need to be defined in this study are milk, sports drink, water, fluid balance, hot and humid condition, and rugby players.

### MILK

In this study, two types of milk were used as experimental drinks. They were:

**i. Low-fat Milk (M)**

Well known low-fat high calcium milk, UHT Recombined Milk (Dutch Lady ® Milk Industries Bhd. (5063-V) Malaysia).

**ii. Sodium added low-fat milk (Na+M)**

Commercially available low-fat high calcium milk, UHT Recombined Milk with additional 20 mmol/l sodium, NaCl (Dutch Lady ® Milk Industries Bhd. (5063-V) Malaysia).

### SPORTS DRINK (SD)

Sports drink is formulated specifically for use during or after sporting activity and for the sake of enhancing exercise performance (Fitzgerald, 2013). It is a beverage containing carbohydrate, electrolytes like sodium, chloride and potassium, and an extensive amount of sugar, designed to help athletes restore water, energy and electrolytes following competition or training (Wilmore, 2008). It helps in restoring fluid balance and prevents dehydration after rigorous exercise and sweating. The sports drink (SD) consumed in this study is GATORADE 500ml (Lemon Lime flavoured), supplied by Permanis Sdn. Bhd. Malaysia.

**WATER (W)**

Water is a liquid at a standard temperature and pressure (Jez-Walkowiak & Pruss, 2012). This liquid is of adequately elevated quality which could be consumed or used with no risk of instant or extended harm. In this research mineral water (W) (Bleu, 600ml, Permanis Sdn. Bhd. Malaysia) is used to ensure the hygiene and composition of water.

**RUGBY PLAYERS**

In this research, the research participants are rugby players (athletes) from Malaysian Putra University [UPM (*Universiti Putra Malaysia*)]. Their chronological age range is between 18 – 23 years, with fairly good fitness level (bleep test: level 8 and above) and almost similar body weight (60 kg -70 kg). All are actively involved in competitive rugby and have represented UPM in inter-university tournaments such as MASUM and SUKIPT. Moreover, all the participants have been going through regular training sessions three to four times a week prior to the study.

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## LIST OF PUBLICATIONS

Patmavathy, A., & Ilangkumaran, S. (2015). Milk in Tamils' Diet. *Muallim Journal of Social Sciences and Humanities (MJSSH)*, 1(2), 60-66.

Patmavathy, A., & Kok, L. Y. (2015). After-Effects of Milk, Sports Drink and Water Consumption in Rugby Players. Paper presented at the ASEAN Universities Conference on Physical Education and Sports Science (1st ACPES' Conference 2015) (5th AUCPESS' Conference), Semarang State University, Semarang City, Indonesia, September 2015.

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Patmavathy, A., & Kok, L. Y. (2014) Effectiveness of Milk, Sports Drink and Water for Restoring Fluid Balance During Hot and Humid Conditions in Rugby Players. Paper presented in a symposium presentation at the Asian Conference for Physical Education and Sports Science (ACPESS), Singapore, July 2014.

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