Hydration assessment of basketball teams

participants of U20 European Championship Men 2011–Division B

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Acknowledgement

First of all, we thank to Mr. Nar Zanolin who has approved our project on the Medical Council meeting in January 2011 and fully supporting project implementation. I deeply thank our FIBA Europe advisor, Mr. Richard Stokes, whose help and support was invaluable. I also thank Dr. Heinz Gunter and colleagues from FIBA Europe Medical Council, with whom I have discussed the project and who gave me the green light.

The most important acknowledgment is going to Dr. Jelena Oblakovic Babic who initially designed the project and Dr. Milica Vukasinovic Vesic who made it real. Comments and work of colleagues who participate substantially improved the project: : Dr. Marija Andjelkovic, Dr. Djordje Curcic, Predrag Radic, Dr. Aleksandar Stamenkovic, Predrag Radifkovic, Dr. Radomir Cabarkapa, Dr. Sinisa Vujic, Dr. Nenad Radivojevic.

Finally, I would like to thank the Ministry of youth and sport, Sports Medicine Association of Serbia and Anti-doping agency of Serbia who logistically and financially support the project.

Dr. Nenad Dikic

CONTENT

1. INTRODUCTION

Many athletes in team sports fail to return to euhydrated state even when opportunities to replace fluids are available.

Some studies showed that basketball players were inadequately hydrated prior the game or practice. Dehydration significantly affects athlete's performance. Inadequate hydration affects: thermoregulatory function which lead to increase of core temperature and reduction of heat tolerance and exercise time to exhaustion; cardiovascular function which can cause possibly lower cardiac output and mean arterial pressure; muscle function in terms of decrease in blood perfusion, elevated muscle temperature, increased rate of glycogen degradation and lactate levels and muscle cramps; gastrointestinal function which means that athletes can feel bloatedness, nausea, gastric discomfort.

Inadequate hydration, also, affects mental / cognitive performance such as decision making, arithmetic ability, short-term memory, ability to concentrate, reduces alertness, visuomotor tracking, response time, coordination, decreases the motivation to exercise, increases the rating of perceived exertion (fatigue), decreases the time to exhaustion (*Osterberg K, Basketball and hydration*).

Some studies suggested that overall basketball performance (combined scores for the entire 80-min simulated game) was significantly impaired ≥ 2% Dehydration (DEH). Also there is significant deterioration in performance: (1)1% DEH - ladder suicide sprints; (2) 2% DEH - around-the-world shooting; (3) 3% DEH - zigzag slides court-width, layup shooting, full-court combination; (4) 4% DEH - repeated vertical jumps, key combination, lane slides, baseline jump shots; (5) ≥ 2% DEH number of shots were attempted and made (*Baker LB. 2007*).

All of this clearly shows need to provide enough fluid for athletes as well as for raising awareness of athletes for taking enough fluids during their practice / game.

FIBA Europe, as active International Federation in fields of sports medicine, supplementation and antidoping, has decided to monitor hydration of basketball players on the one major European competition.

According to FIBA Europe regulations organizer of official Championship should supply for the teams:

1. Drinking water for each team to use during games and practices should be free of charge (from the first to the last day of the competition plus two (2) days).
2. All drinking water should be industrially bottled/barrelled still water, not tap water.
3. The following amount of drinking water should be provided:
    a. For each team to use during the practices: At least twelve (12) bottles of 1.5 litres still water for players. At least six (6) bottles 0.5 litres still water for team staff members
    b. For each team to use during the games: At least eighteen (18) bottles of 1.5 litres still water for players. At least six (6) bottles of 0.5 lt. still water for the team staff members.

Many teams have regularly requested more water.

2. STUDY BACKGROUND

This study had been conducted during U20 European Championship Men 2011-Division B Championship held in Sarajevo from July 14th to July 24th.

FIBA Europe Medical team arrived in Sarajevo on July 12th and departure on July 17th. To ensure study success FIBA Europe Medical team members were placed in same hotel as participants. From each team one contact person were appointed for cooperation with FIBA Europe Medical team. FIBA Europe Medical team members were granted access to all 3 sport halls (Skenderija, Ilidja Gym, Ramiz Salcin-Mojmilo) where games were played, to locker rooms more than 90 minutes before the game and after game and next to team benches during game. Also, all water bottles for the players were marked and measured before, during and after game, as well as urine volume for each player during game. FIBA Europe Medical team got full statistics of each game and measured environmental conditions during game.

On technical meeting FIBA Europe Medical team delivered questioners, which were translated on each team language and small urine bottles in the boxes for the first morning urine sample for each team. Appointed person for each team collected urine samples from each player for 3 consecutive days. Fourth sample were taken after one game. FIBA Europe Medical team marked urine samples only with assigned code for each country and numbers without player names. Urine colour was determined with colour rating chart and urine specific gravidity with refractometer on the spot. Full urine analysis and osmolality were performed in Military Medical Academy in Belgrade.

Players body mass were measured before and after game.

Following teams (bolded) were monitored:

On July 14th:

13.00 **FYR Macedonia** – Poland

15.30 Romania – **Estonia**

21.15 Iceland – **Bosnia and Hercegovina**

On July 15th:

14.00 Czech Republic – **Portugal**

20.00 **Great Britain – Finland**

On July 16th:

17.30 **Netherlands** - **Bulgaria**

On July 17th

FIBA Europe Medical Team left Sarajevo.

To follow results in study please note that national teams are marked with numbers, since each team should see only own results in order to compare with other participating teams results without knowing the name of the others.

3. STUDY OBJECTIVES

1. To assess knowledge and hydration habits of basketball players;
2. To assess voluntary fluid intake of basketball players during game;
3. To assess fluid losses and sweat rates of players during game;
4. To investigate different fluid replacement needs between different playing positions;
5. To follow hydration status from day-to-day (to examine level of hydration in the morning and prior the game during several consecutive days of tournament);
6. To provide useful recommendation for organizer and FIBA Europe of (summer) tournaments in purpose to optimize and encourage fluid replacement for athletes;
7. To provide teams with feedback about their fluid intake habits.

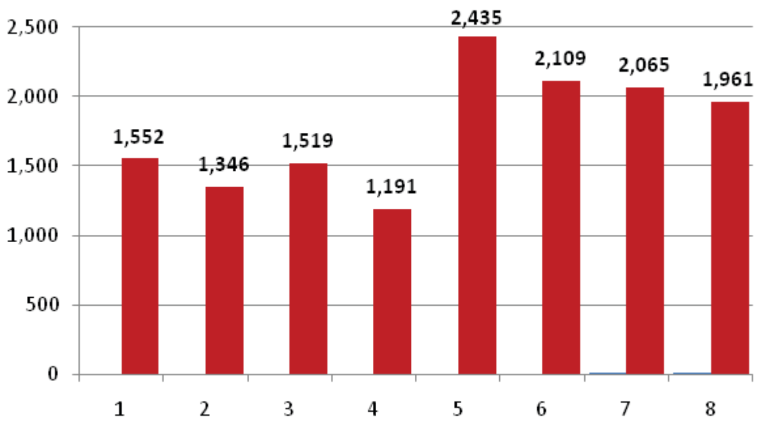
4. STUDY RESULTS

4.1 AVERAGE FLUID INTAKE BY TEAMS

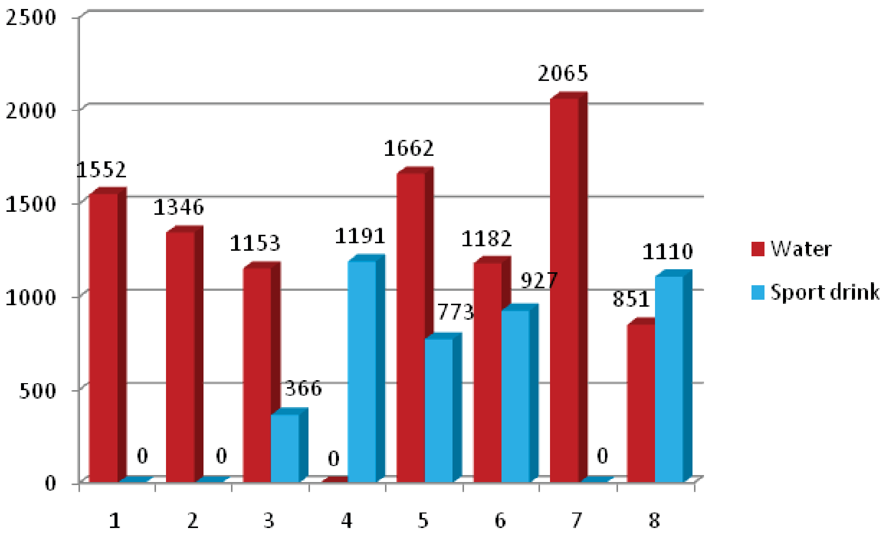
Following graphs shows average fluid intake of each national team. Players from all national teams took 1772 ml of fluid in average during game.

According to some recommendations adequate hydration could be managed by (*Casa DJ, Armstrong LE, et.al. 2000*):

- 200 to 300 ml every 10 to 20 min;
- 200 ml at quarter breaks + 400 ml at half time + 100 ml at 1 timeout;
- 443±251 ml after 1st quarter + 575 ±192 ml after 2nd quarter + 430±191 ml after 3rd quarter

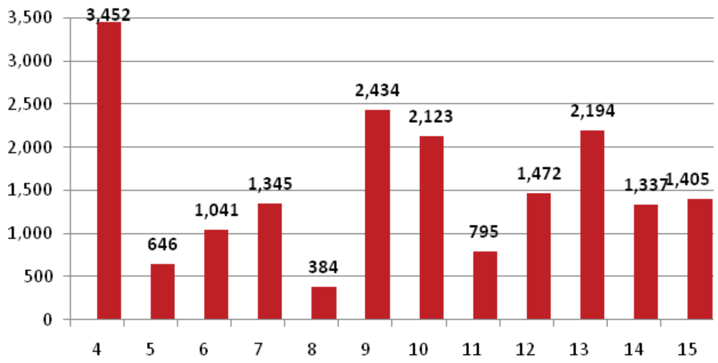


Graph 4.1.1 Average total fluid intake by teams (in ml)

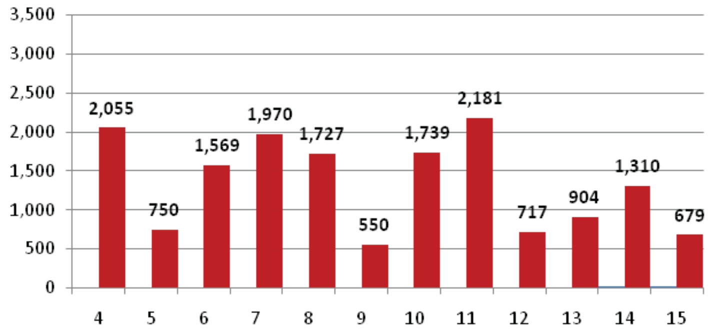


Graph 4.1.2 Average water and sport drinks intake by teams (in ml)

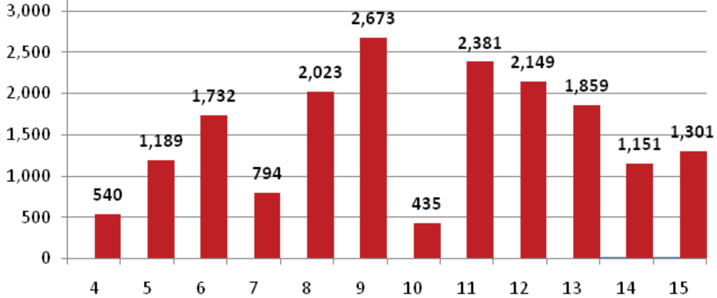
Following graphs show average fluid intake for each player from all participating teams in study:



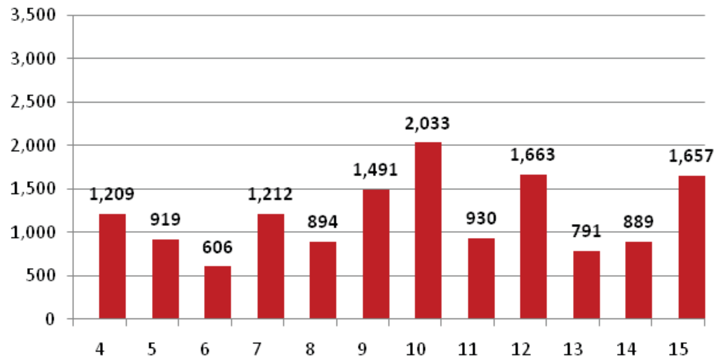
Graph 4.1.3 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 1 (in ml)



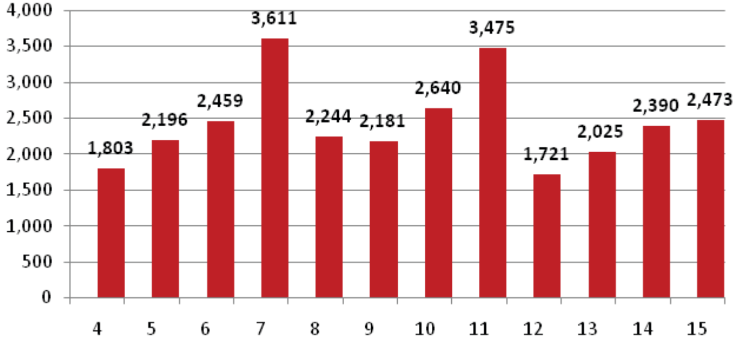
Graph 4.1.4 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 2 (in ml)



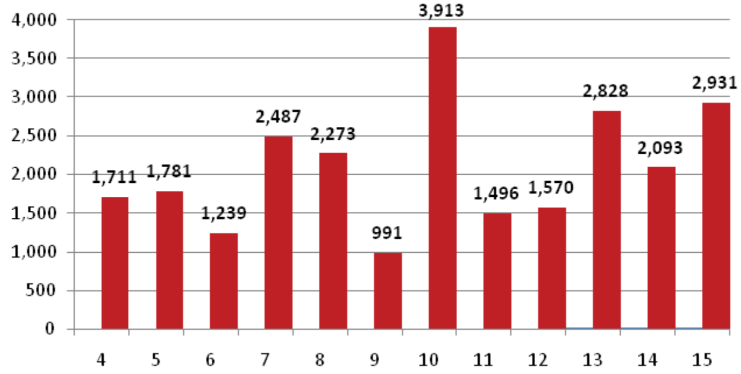
Graph 4.1.5 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 3 (in ml)



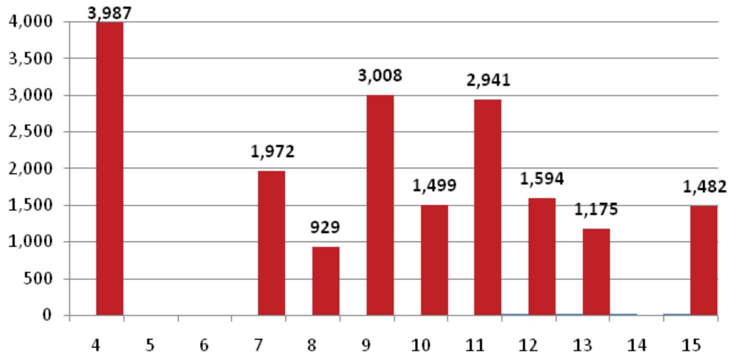
Graph 4.1.6 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 4 (in ml)



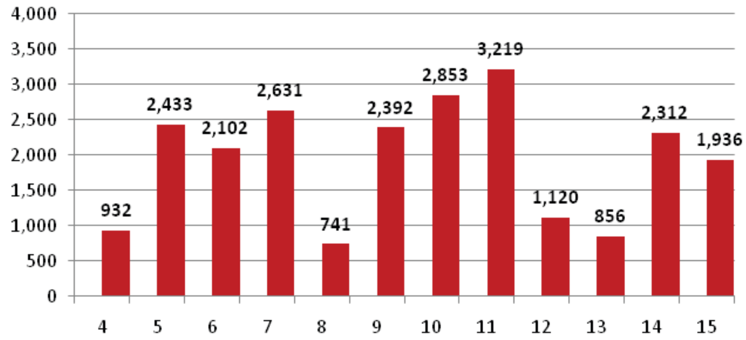
Graph 4.1.7 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 5 (in ml)



Graph 4.1.8 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 6 (in ml)



Graph 4.1.9 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 7 (in ml)



Graph 4.1.10 AVERAGE FLUID INTAKE BY PLAYERS FOR TEAM 8 (in ml)

4.2 ANALYSIS OF WATER AND SPORT DRINKS USED BY TEAMS

Organizer of the U20 European Championship Men 2011-Division B has provided Natural Mineral Water „KAP“ which in 1000 ml contains:

CATIONS (mg/l)	ANIONS (mg/l)
Na+K = 6,97	HCO3 = 364,78
Ca = 102,6	SO4 = 40,00
Mg = 114,2	CI = 9,58
NH4 = 0,00	NO2 = 0,00
SR = 0,02	NO3 = 5,25
FE = 0,01	F = 0,25
Li = 0,0002	J = /
Mn = 0,00	Br= /
Ba = 0,004	Cn = 00,5
	HPO2 = 0,11

Table 4.2.1

Team 3

Name of sport drink – DM 100 gr Containes

Protein = 0	Na = 0,59 g
Carbohydrates = 91 g	Mg = 95 mg
Sugar = 71 g	Ca = 200 mg
Fat = 0	K = 250 mg
	Vit C = 225 mg
	L –karnitin =177mg

Table 4.2.2

Team 4

Name of sport drink – BTN biotech nutrition, multy hypotonic drink 10 ml contains:

Protein = 0,02	Taurin = 50mg
Carbohydrates =7,4g	Vit E = 2mg
Fat = 0	C = 30mg
Na = 63,80 mg	B1 = 0,28mg
K = 37mg	B2 = 0,32mg
Ca = 25mg	B3 = 3,6mg
Mg = 25mg	B5 = 1,2mg
P = 38,7mg	B6 = 0,4mg
Cl = 71,2mg	B12 = 0,2mg
	Biotin = 30mg
	Folic acid = 40mg

Table 4.2.3

Team 5

100 g of Gel contains:

Protein < 1 g	Na = 0,50 g
Carbohydrates = 65 g	Cl = 660 mg
Sugar = 24 g	
Fat < 0,1	

Table 4.2.4

100 g of isotonic solution contains:

Protein = 0,5g	L glutamin = 250 mg
Carbohydrates = 95,1 gr	L leucin = 110
sugar = 60,3gr	Lvalin = 100
Fat <0,1	L isoleucin = 70
Na = 0,9gr	Vitamin C = 52mg
Mg = 48,7 mg	Vitamin E = 26mg
	Niacin = 18 mg
	Vitamin B6 = 1,8mg
	Vitamin B1 = 0,81mg

Table 4.2.5

Team 6

Name of sport drink –Lucosade (500 ml) contains:

Proteins = 0	Niacin = 3,1 mg
Carbohydrates = 33 g	Vit B6 = 0,34 mg
Sugar = 17,8 g	Vit B12 = 0,17 mg
Fat = 0	Pantotenic acid = 1mg
Na = 200 mg	

Table 4.2.6

Team 8

Name of sport drink – Flow 100 ml contains:

Protein = 0,5 g	Fibers = 0
Carbohydrates = 5,8 g	Na = 28 mg
Of which sugar = 5,1g	Caffeine = 7,2 mg
Fat = 0	

Table 4.2.7

Ingredisents: Water, fructose, glucose, lactic acid, aminoacid premix, juice concentrate, apple, lingonberry, bilberry and lemone, glycerol, trimagnesium di citrate, natural flavor, sodium hloride, L-carnitine 0,72%, guarana extract; Preservatives: potassium sorbate, sodium benzoate, taurine, tripotasium citrate, green tea extract, extract of french maritime pine bar 0,036%, inositol

4.3 AVERAGE SWEAT RATE BY TEAMS

When competition takes place over a period of consecutive days it is reasonable to expect sweat losses may be high as a result of repeated bouts of high intensity exercise (match).

Average sweat rates from the scientific literature or other athletes can vary from 0.5 l/h to more than 2.5 l/h (0.50 to 2.50 kg/h). (*Baker LB, Dougherty KA, et.al. 2007*)

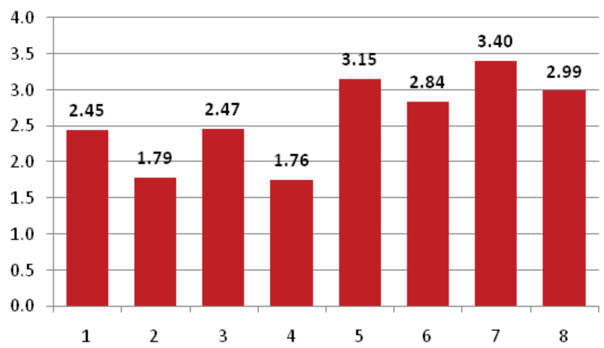
American College of Sports Medicine estimated sweat rate for male basketball players during summer competitions in range from 1.23 to 1.97 l/h.

Calculation formula for sweat rate: SwR = (pre-exercise body weight – post-exercise body weight + fluid intake – urine volume)/exercise time in hours.

Exercise can bring out high sweat rates and substantial water and electrolyte losses during sustained exercise, particularly in warm-hot weather. Studies have recorded the sweat rates of athletes in a wide range of sports, and have unsurprisingly recorded a wide range of results.

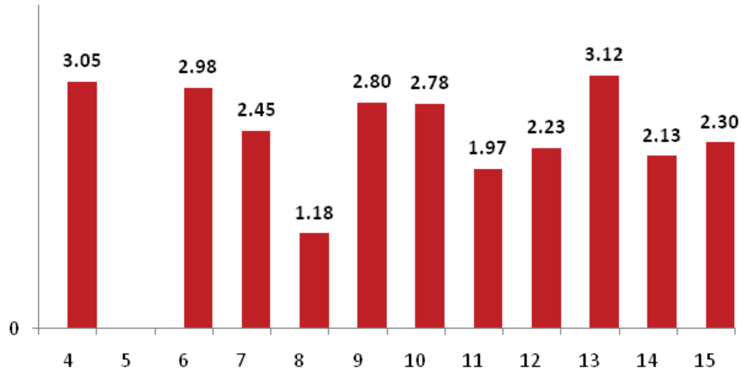
Sweat rates and sweat composition depend principally on factors such as the environmental conditions (ambient temperature and humidity), choice of clothing or exercise intensity and they also vary greatly between individuals.

Following graph shows range of average sweat rate during U20 European Championship Men 2011-Division B Championship from 1.79 to 3.40 l/h. One of the reasons for such high level of sweat rate is average temperature which was very high 28,2 C range 26,4-32,5 and average humidity 54,8 % , range 47%-60%.

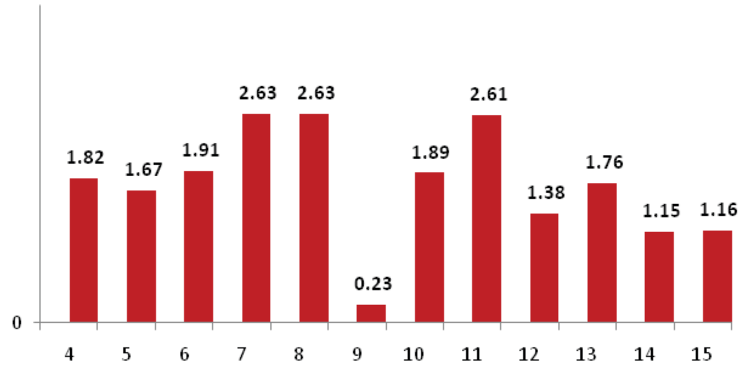


Graph 4.3.1 Average sweat rate by teams (MEDIAN, in l\h)

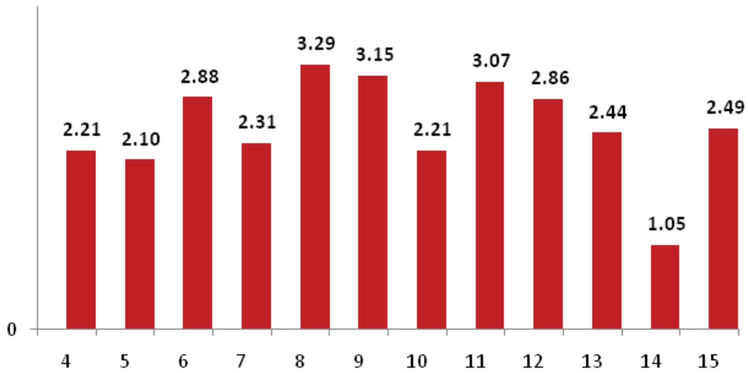
Average sweat rate by players



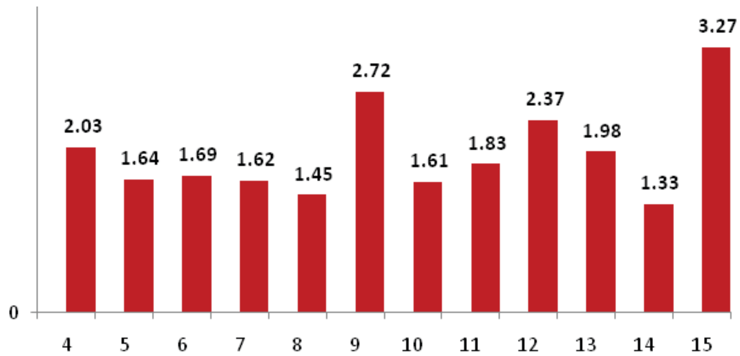
Graph 4.3.2 Team 1



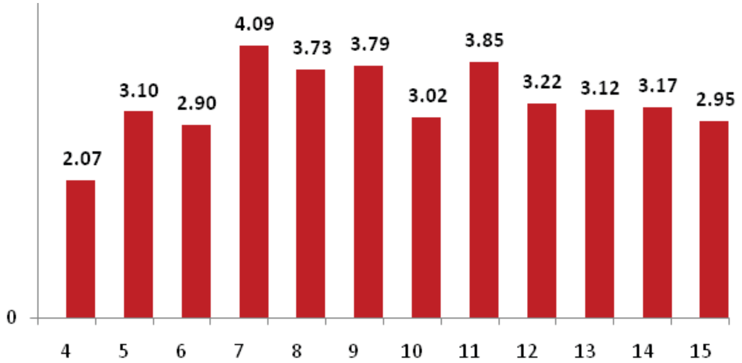
Graph 4.3.3 Team 2



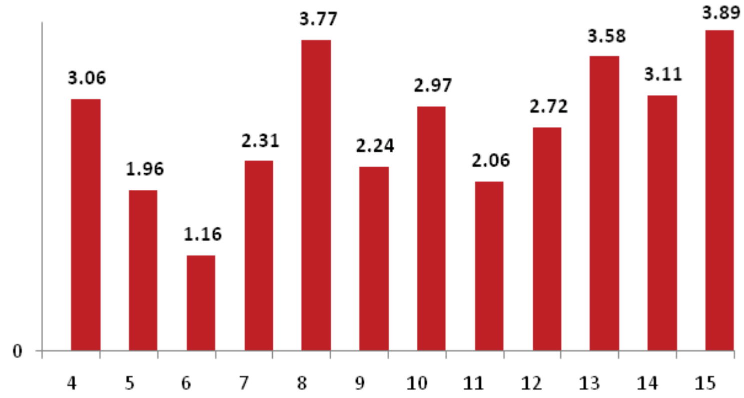
Graph 4.3.4 Team 3



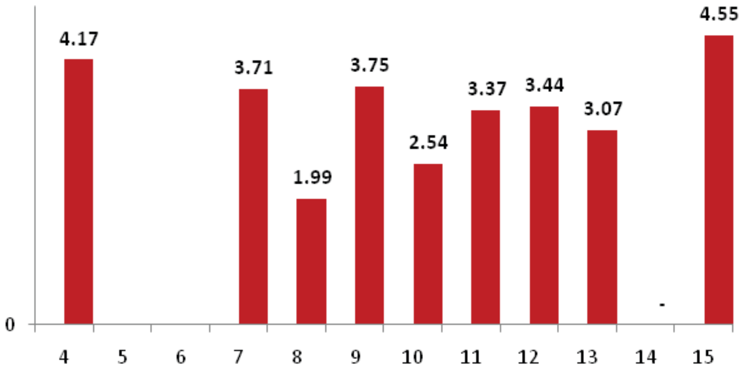
Graph 4.3.5 Team 4



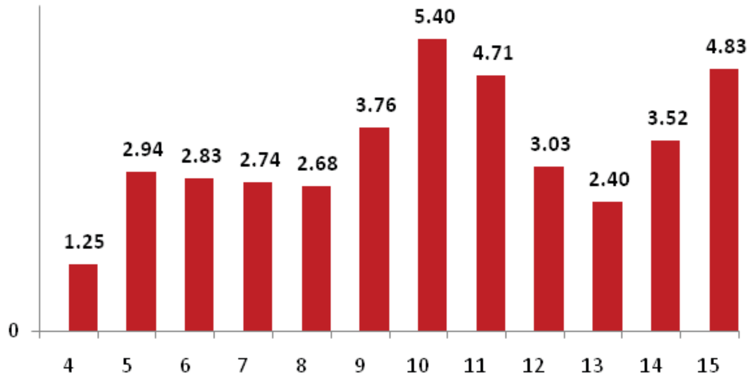
Graph 4.3.6 Team 5



Graph 4.3.7 Team 6



Graph 4.3.8 Team 7



Graph 4.3.9 Team 8

5. HYDRATION STATUS

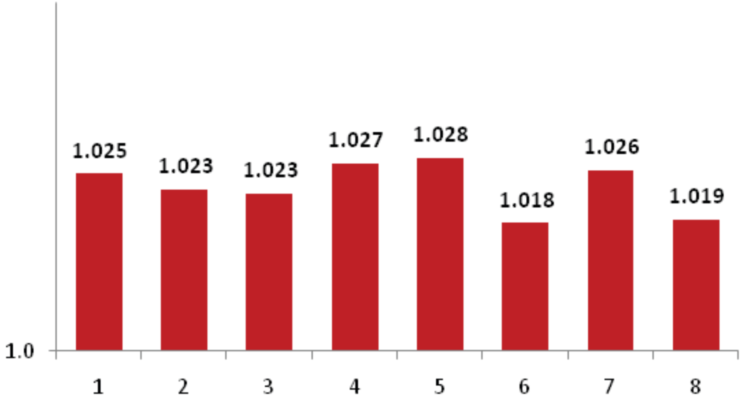
For evaluation of hydration status, three different parameters have been used: (1) specific urine gravity; (2) urine color and (3) osmolality.

5.1 URINE SPECIFIC GRAVITY

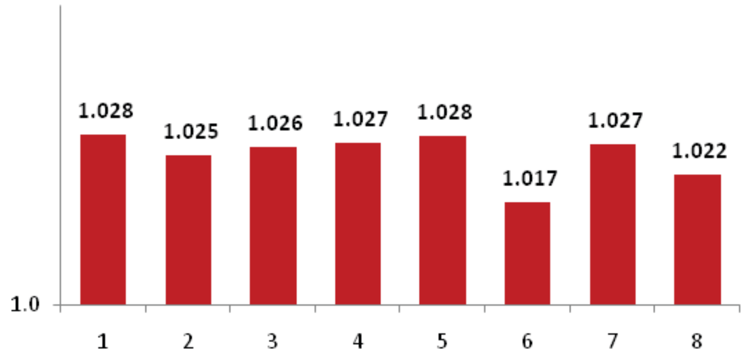
Urine specific gravity is the density of a urine sample compared with the density of water. The specific gravity of the sample is dependent on its osmolality as well as its concentration of urea, glucose and protein.

If urine specific gravity is: under 1010 we are talking about well hydrated condition, from 1010 to 1020 minimal dehydration status, from 1021 to 1030 about significant dehydration status and above 1030 about serious (*Baker LB, Dougherty KA, et.al 2007*).

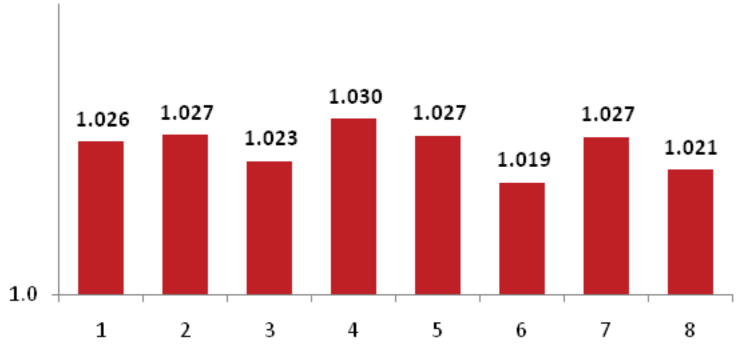
AVERAGE URINE SPECIFIC GRAVITY BY TEAMS



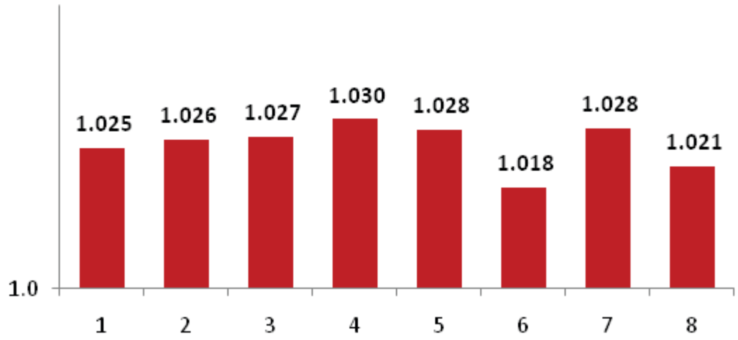
Graph 5.1.1 Day 1



Graph 5.1.2 Day 2

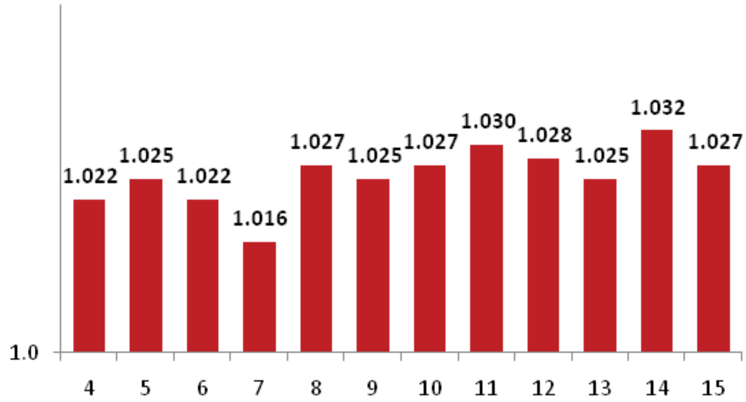


Graph 5.1.3 Day 3

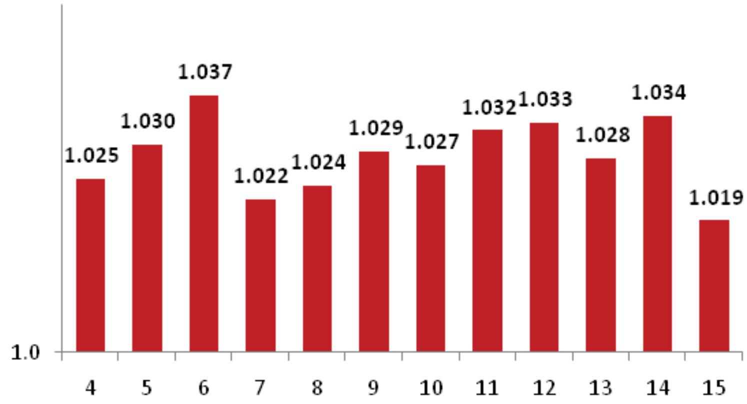


Graph 5.1.4 After game

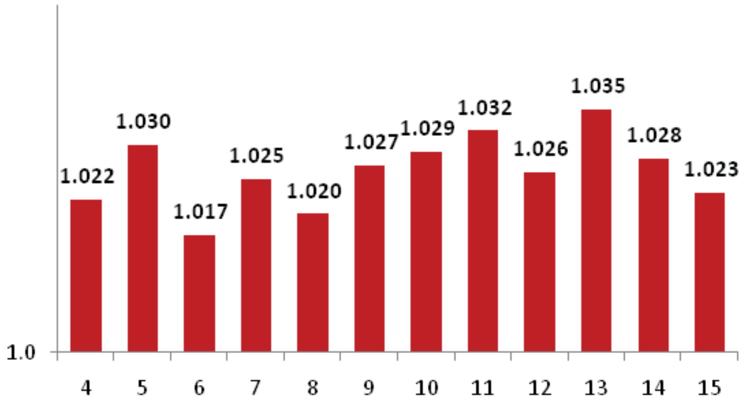
AVERAGE MORNING URINE SPECIFIC GRAVITY BY PLAYERS



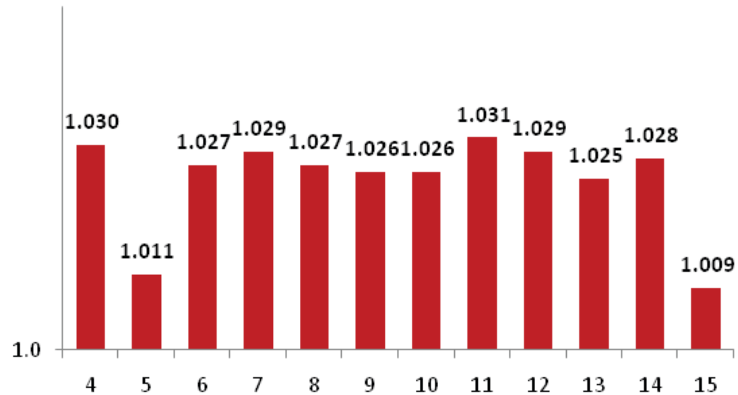
Graph 5.1.5 Team 1, Day 1



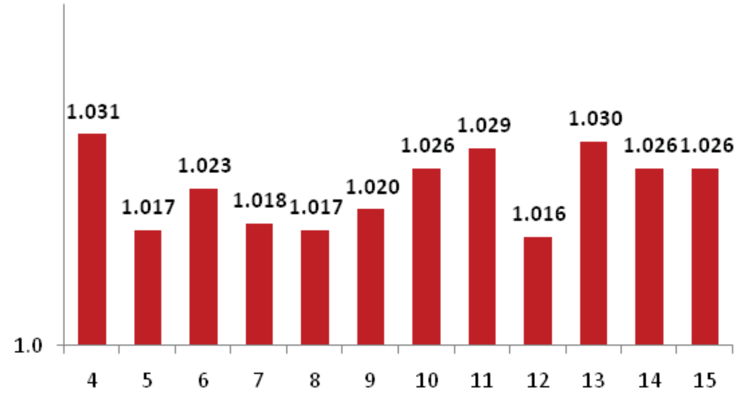
Graph 5.1.6 Team 1, Day 2



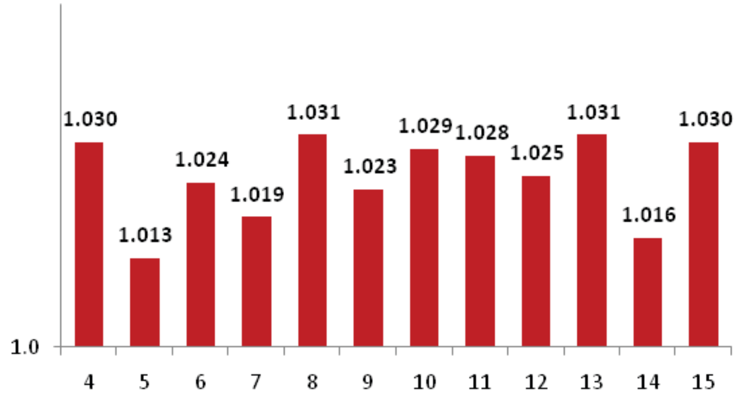
Graph 5.1.7 Team 1, Day 3



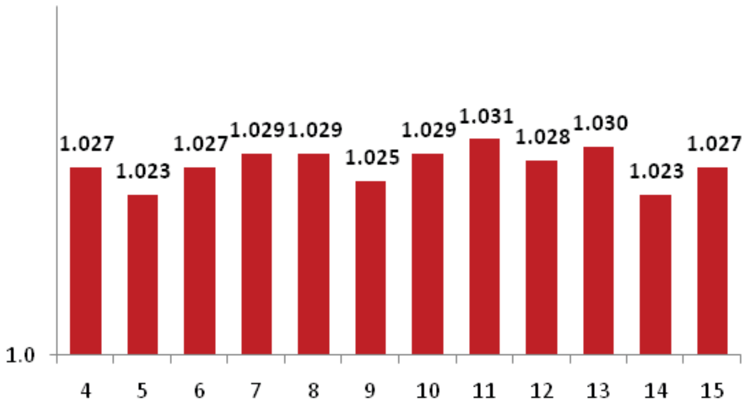
Graph 5.1.8 Team 1, After game



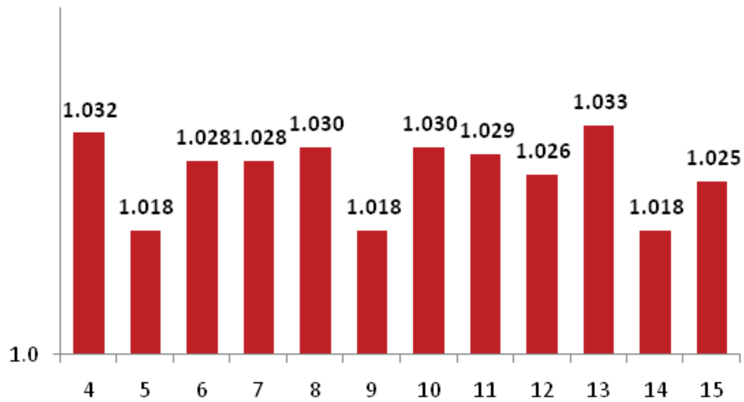
Graph 5.1.9 Team 2, Day 1



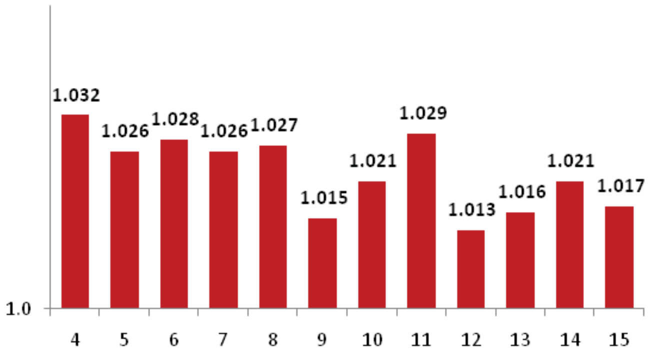
Graph 5.1.10 Team 2, Day 2



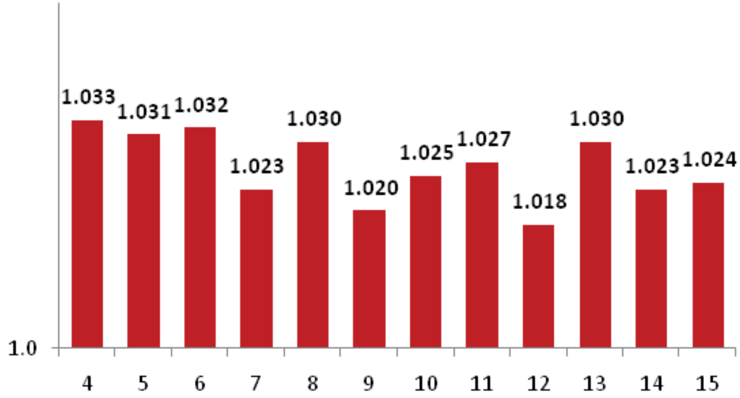
Graph 5.1.11 Team 2, Day 3



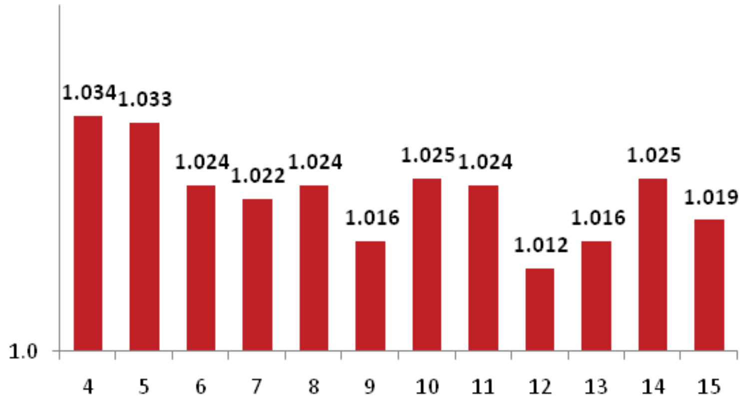
Graph 5.1.12 Team 2, After game



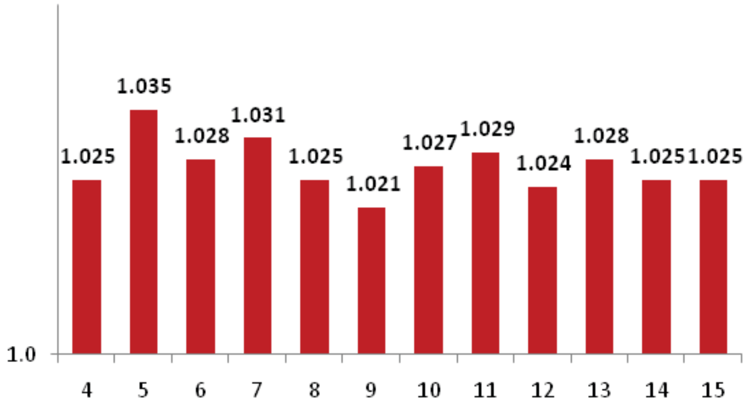
Graph 5.1.13 Team 3, Day 1



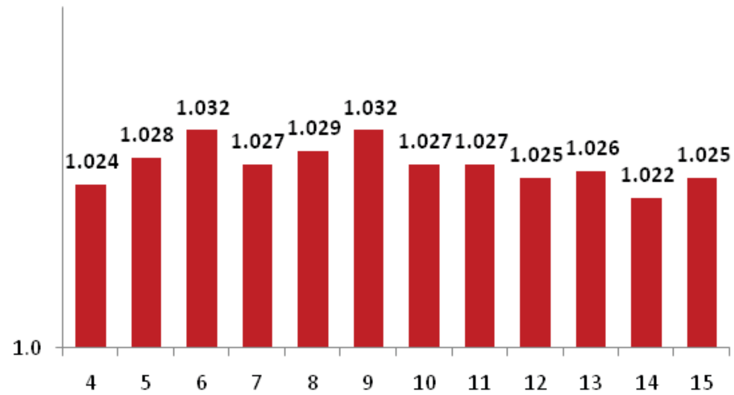
Graph 5.1.14 Team 3, Day 2



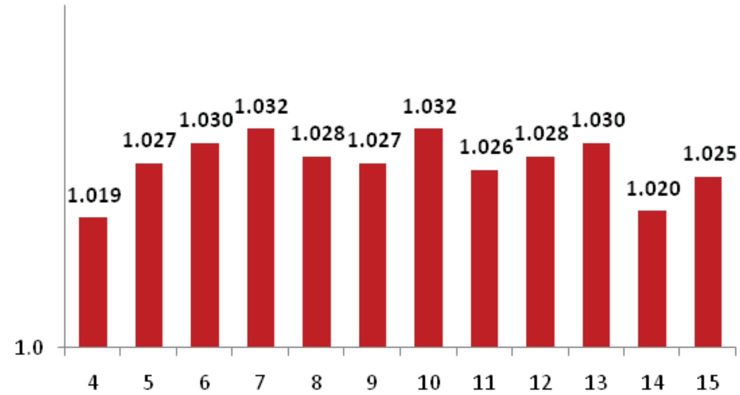
Graph 5.1.15 Team 3, Day 3



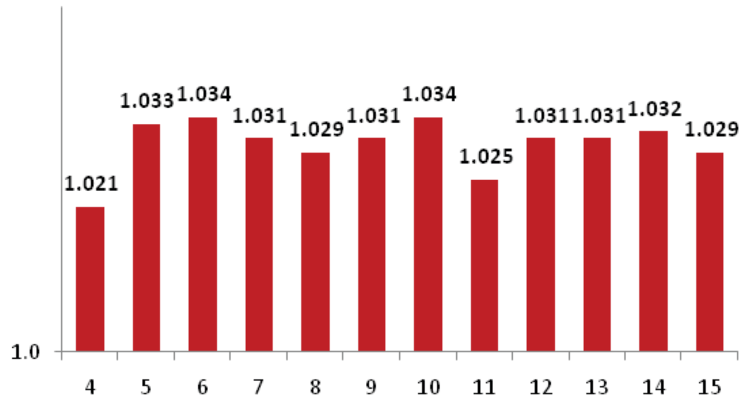
Graph 5.1.16 Team 3, After game



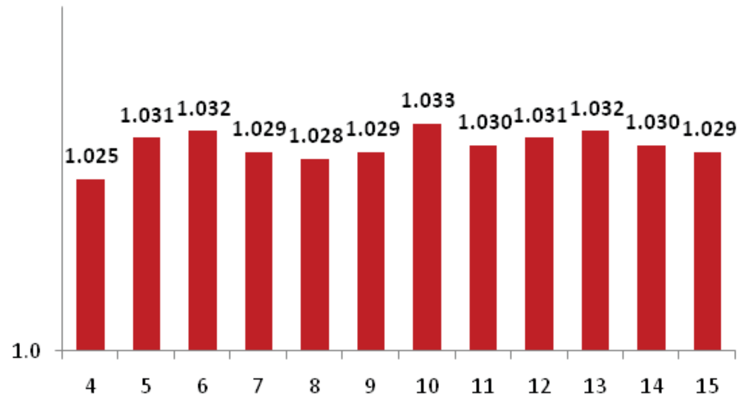
Graph 5.1.17 Team 4, Day 1



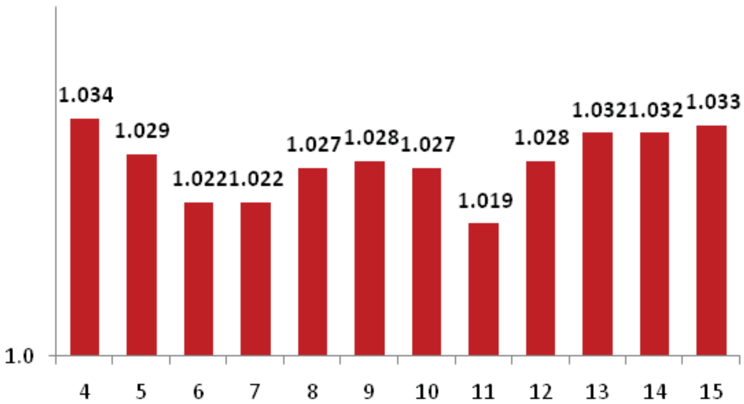
Graph 5.1.18 Team 4, Day 2



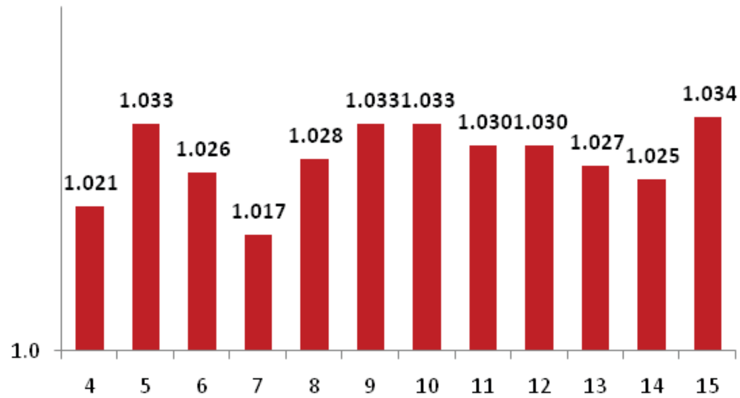
Graph 5.1.19 Team 4, Day 3



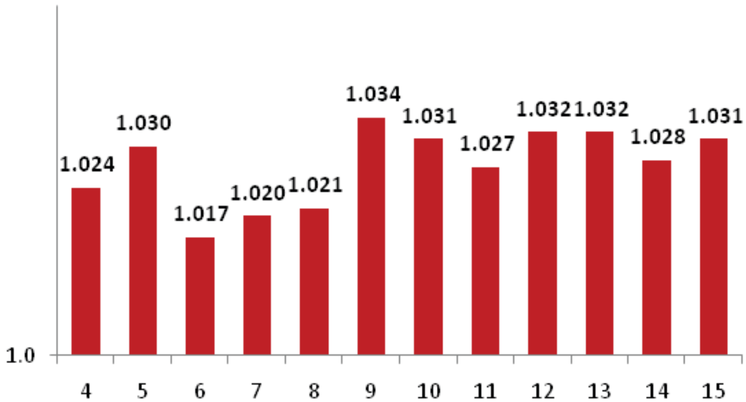
Graph 5.1.20 Team 4, After game



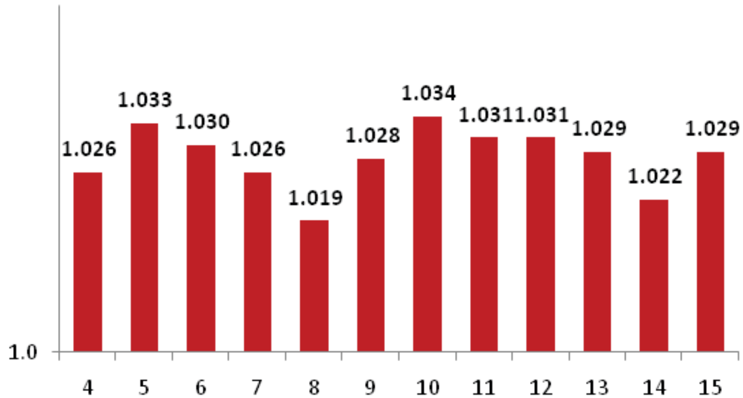
Graph 5.1.21 Team 5, Day 1



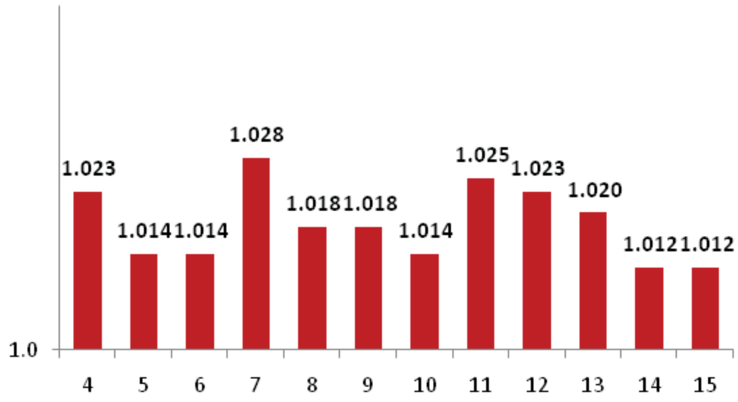
Graph 5.1.22 Team 5, Day 2



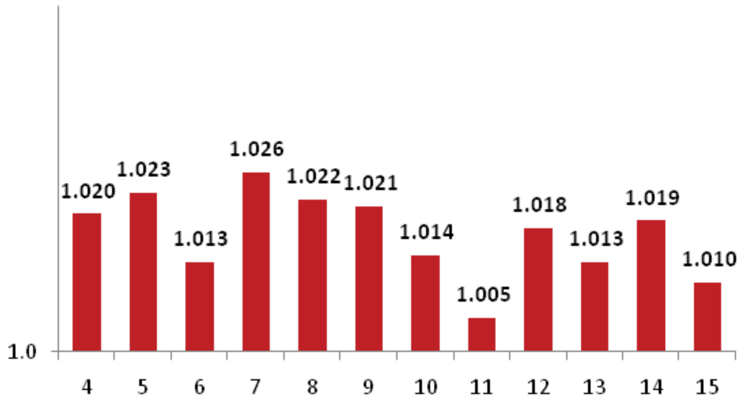
Graph 5.1.23 Team 5, Day 3



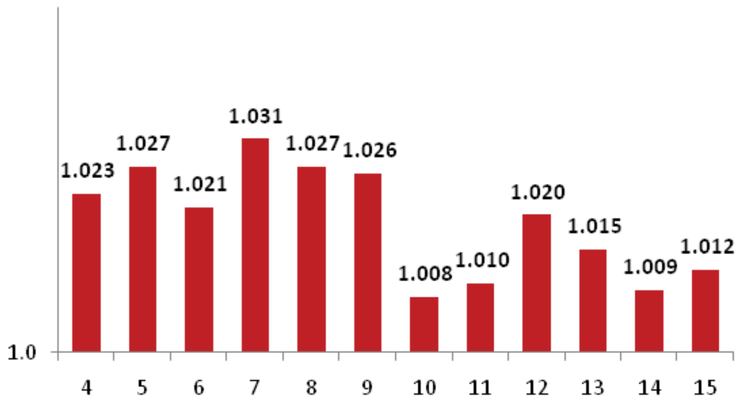
Graph 5.1.24 Team 5, After game



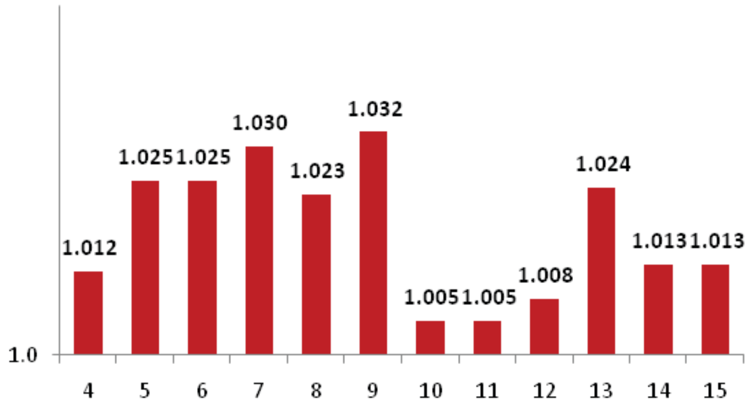
Graph 5.1.25 Team 6, Day 1



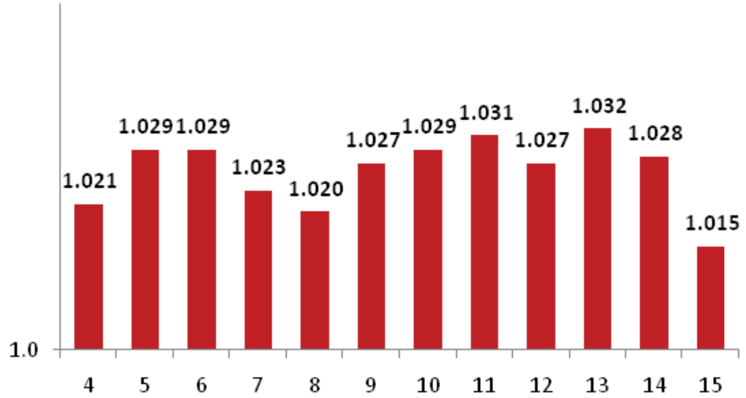
Graph 5.1.26 Team 6, Day 2



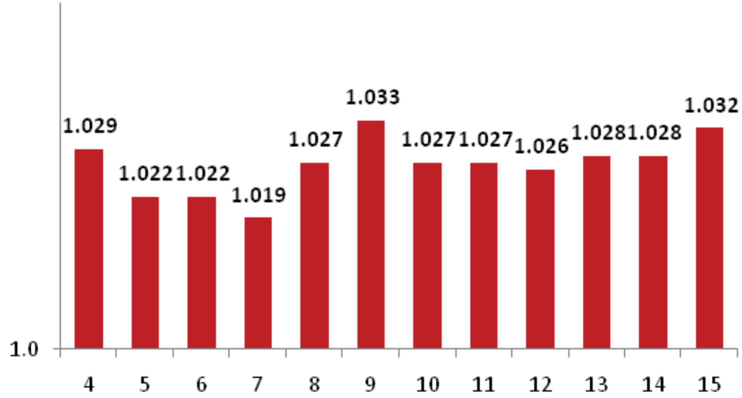
Graph 5.1.27 Team 6, Day 3



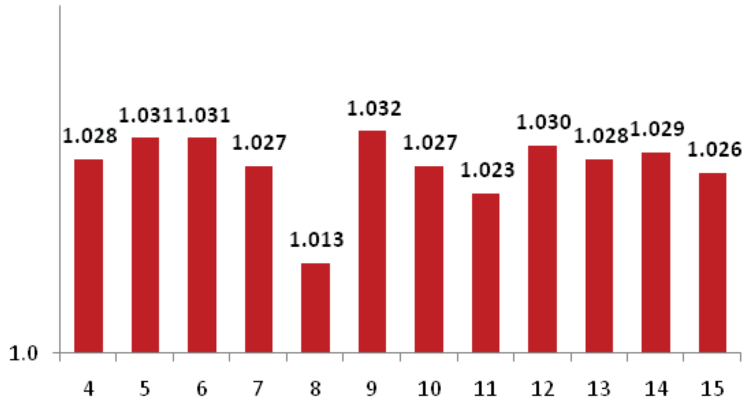
Graph 5.1.28 Team 6, After game



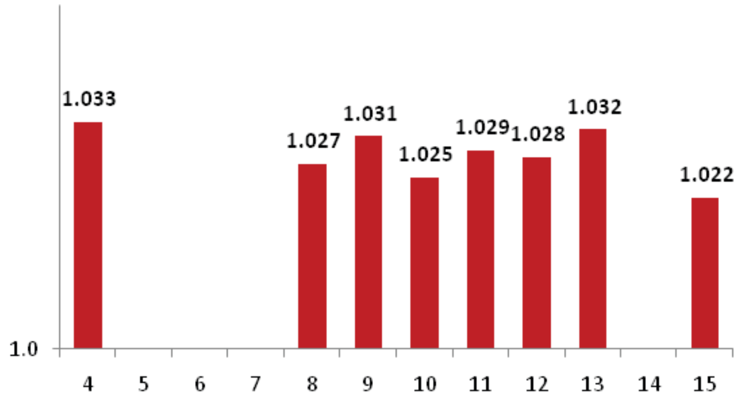
Graph 5.1.29 Team 7, Day 1



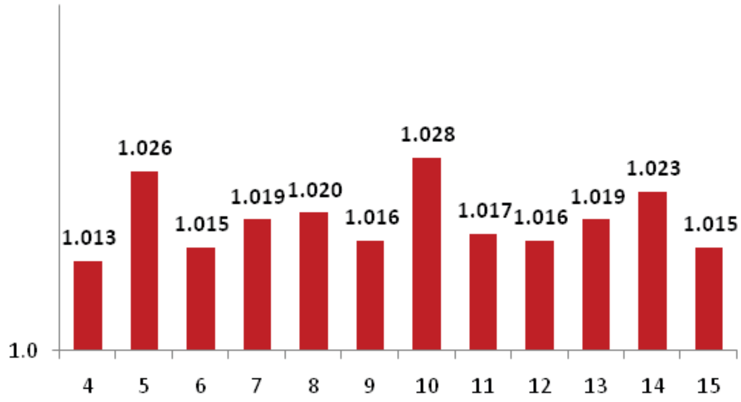
Graph 5.1.30 Team 7, Day 2



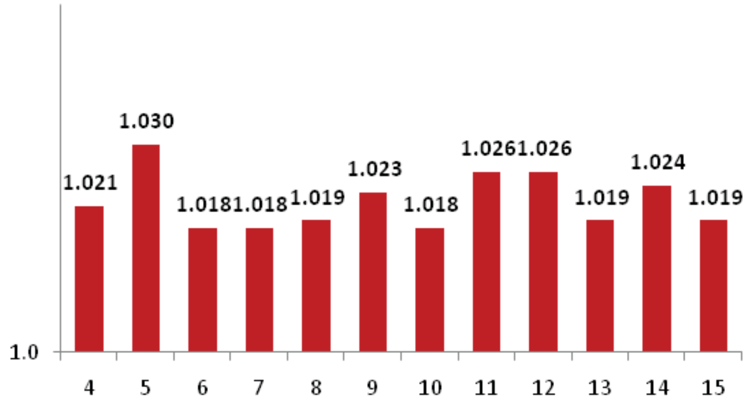
Graph 5.1.31 Team 7, Day 3



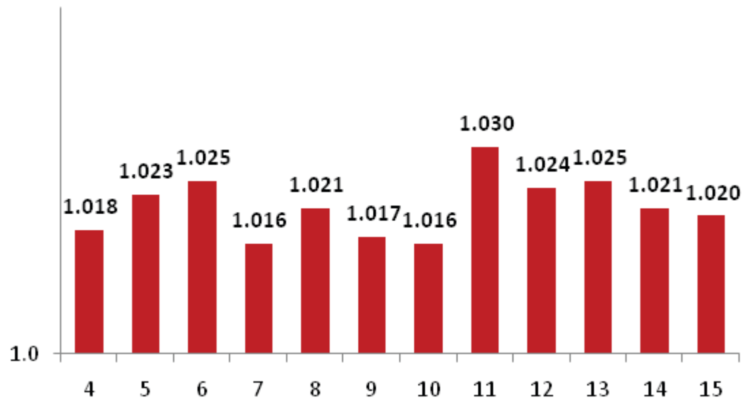
Graph 5.1.32 Team 7, After game



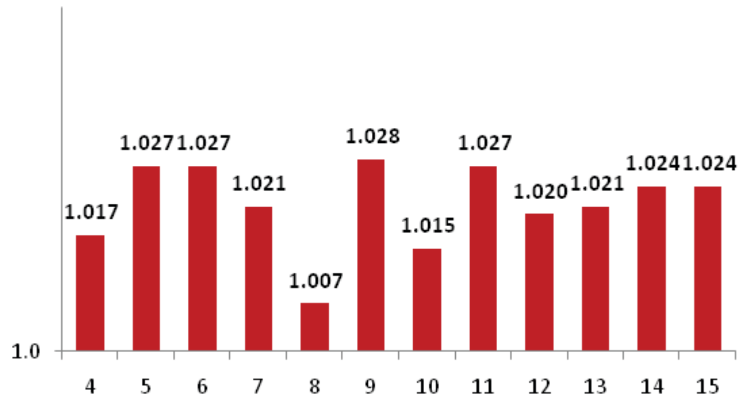
Graph 5.1.33 Team 8, Day 1



Graph 5.1.34 Team 8, Day 2

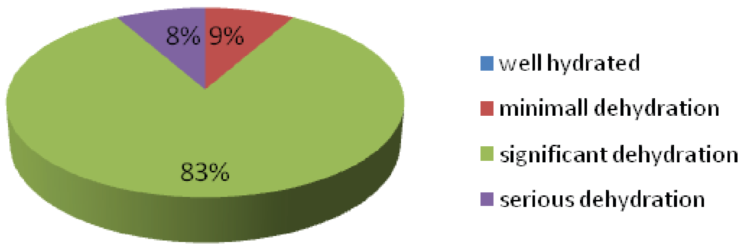


Graph 5.1.35 Team 8, Day 3

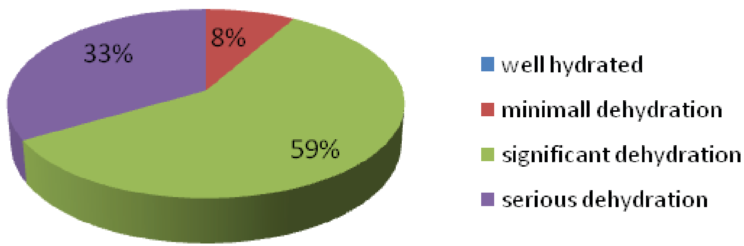


Graph 5.1.36 Team 8, After game

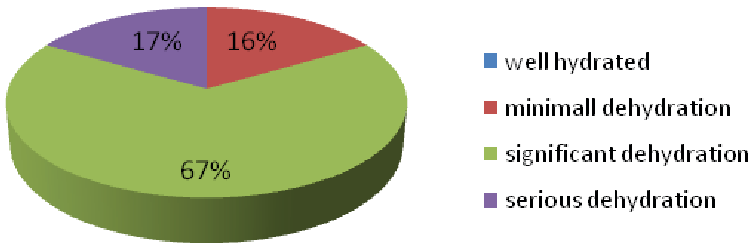
HYDRATATION STATUS -TEAM 1 (BY SPECIFIC GRAVITY)



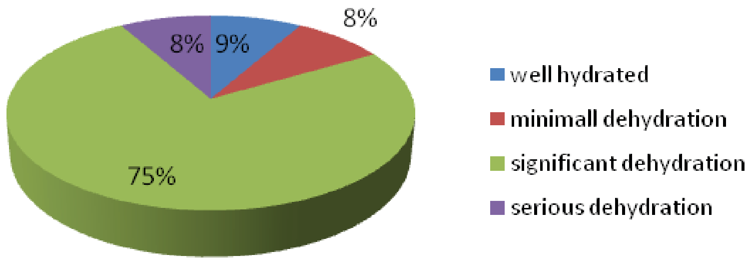
Graph 5.1.37 Morning urine, day 1



Graph 5.1.38 Morning urine, day 2

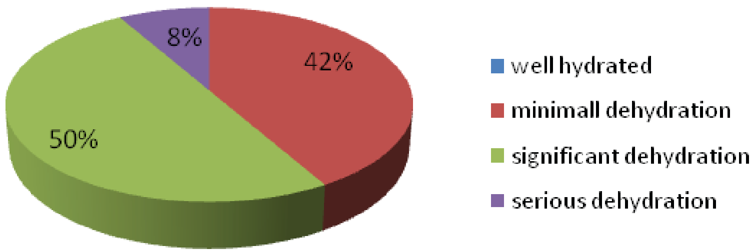


Graph 5.1.39 Morning urine, day 3

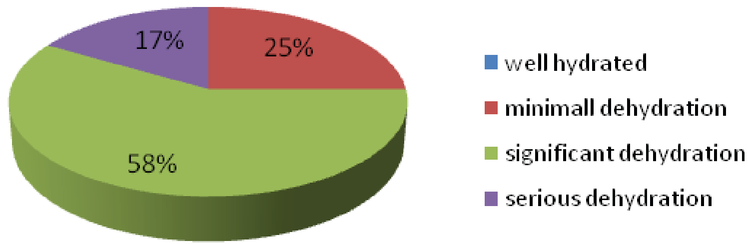


Graph 5.1.40 Urine after game

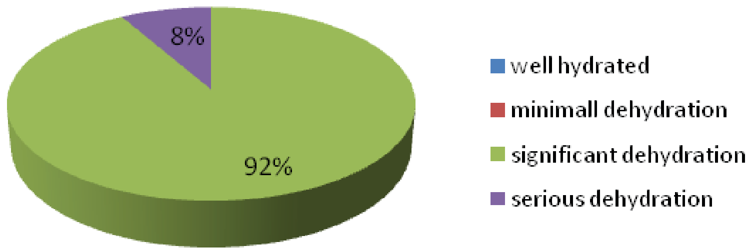
HYDRATATION STATUS -TEAM 2 (BY SPECIFIC GRAVITY)



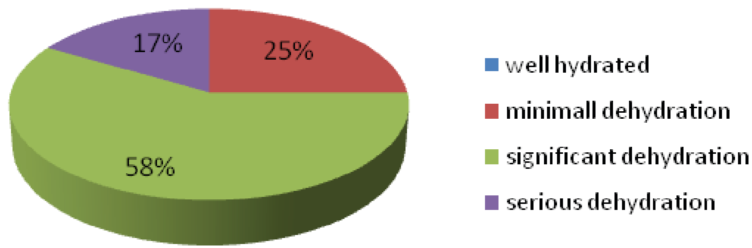
Graph 5.1.41 Morning urine, day 1



Graph 5.1.42 Morning urine, day 2

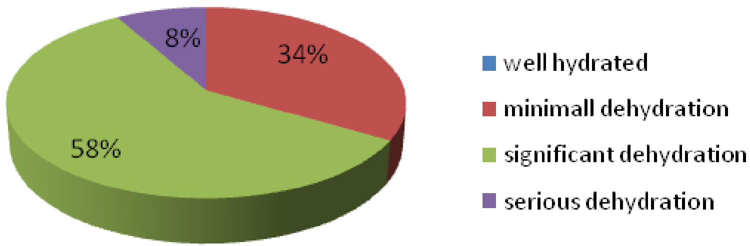


Graph 5.1.43 Morning urine, day 3

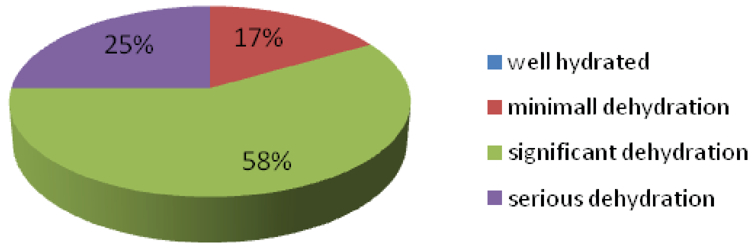


Graph 5.1.44 Urine after game

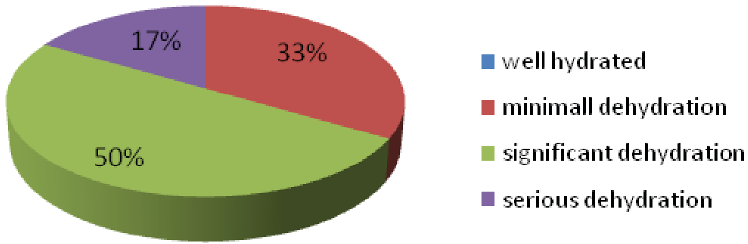
HYDRATATION STATUS -TEAM 3 (BY SPECIFIC GRAVITY)



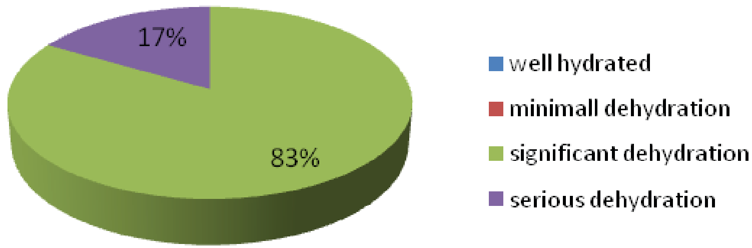
Graph 5.1.45 Morning urine, day 1



Graph 5.1.46 Morning urine, day 2

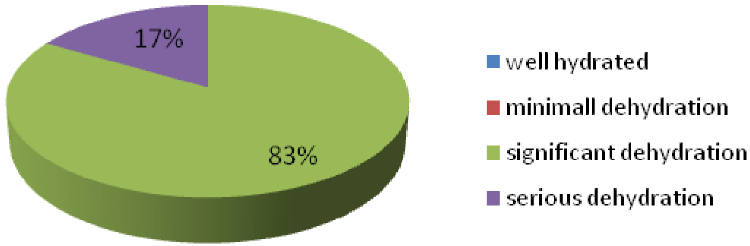


Graph 5.1.47 Morning urine, day 3

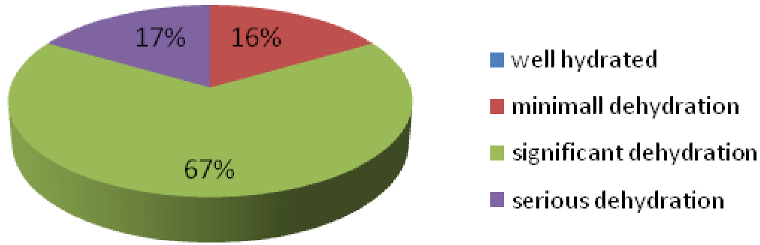


Graph 5.1.48 Urine after game

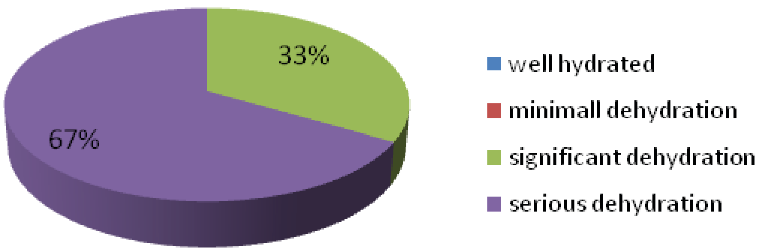
HYDRATATION STATUS -TEAM 4 (BY SPECIFIC GRAVITY)



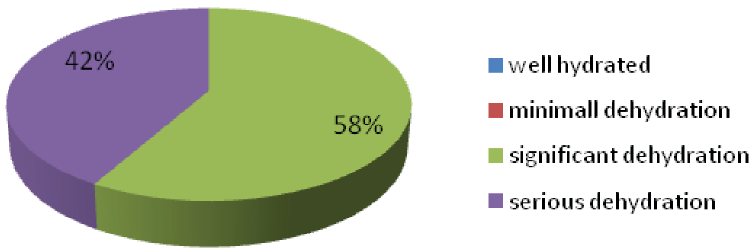
Graph 5.1.49 Morning urine, day 1



Graph 5.1.50 Morning urine, day 2

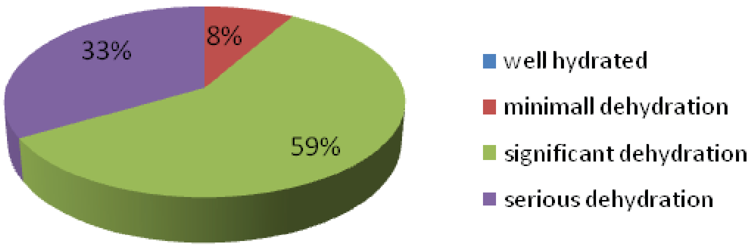


Graph 5.1.51 Morning urine, day 3

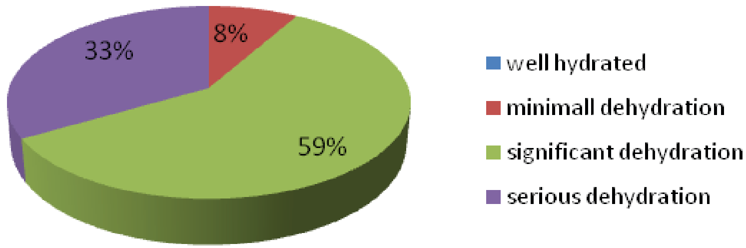


Graph 5.1.52 Urine after game

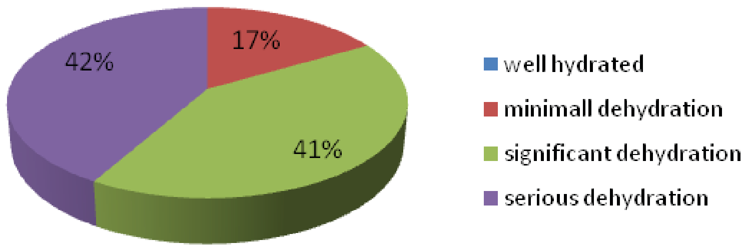
HYDRATATION STATUS -TEAM 5 (BY SPECIFIC GRAVITY)



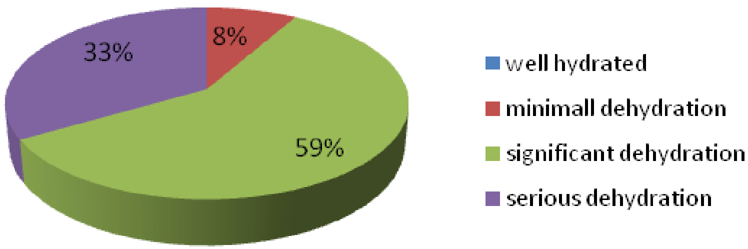
Graph 5.1.53 Morning urine, day 1



Graph 5.1.54 Morning urine, day 2

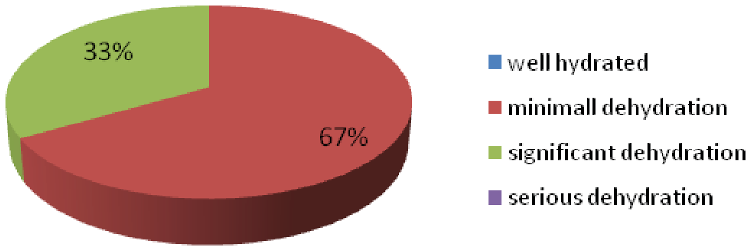


Graph 5.1.55 Morning urine, day 3

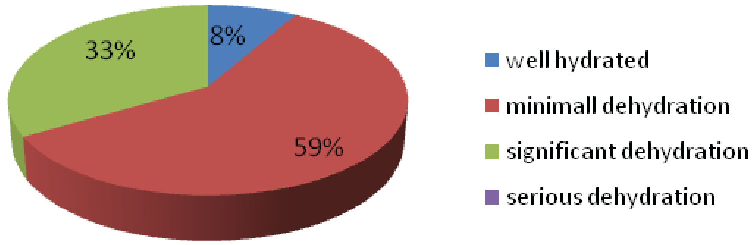


Graph 5.1.56 Urine after game

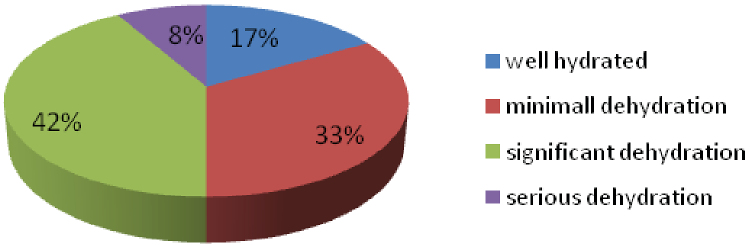
HYDRATATION STATUS -TEAM 6 (BY SPECIFIC GRAVITY)



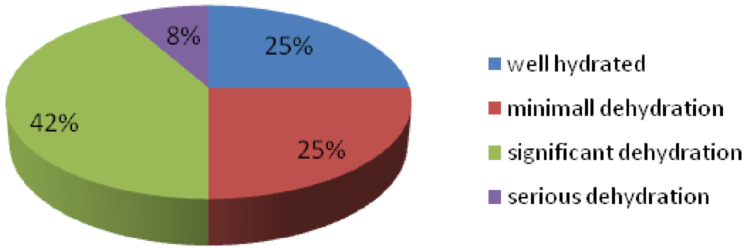
Graph 5.1.57 Morning urine, day 1



Graph 5.1.58 Morning urine, day 2

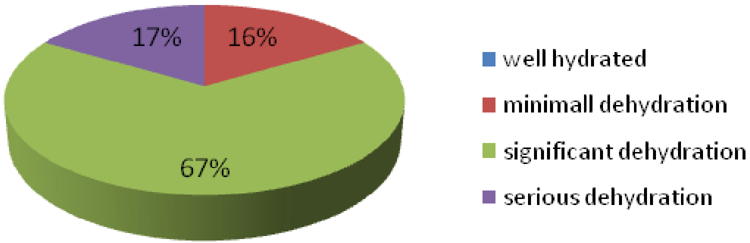


Graph 5.1.59 Morning urine, day 3

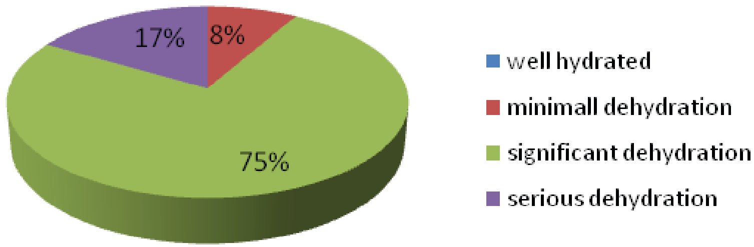


Graph 5.1.60 Urine after game

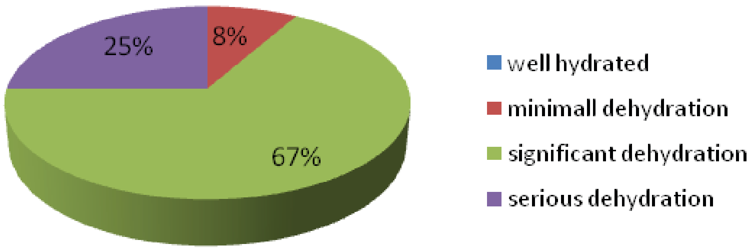
HYDRATATION STATUS -TEAM 7 (BY SPECIFIC GRAVITY)



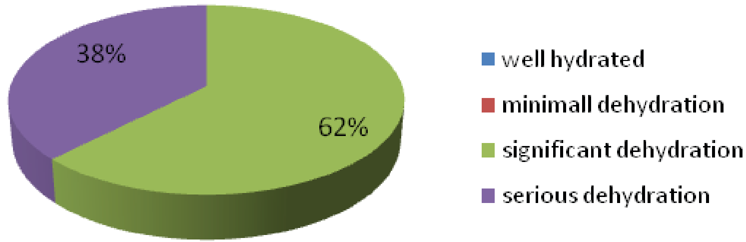
Graph 5.1.61 Morning urine, day 1



Graph 5.1.62 Morning urine, day 2

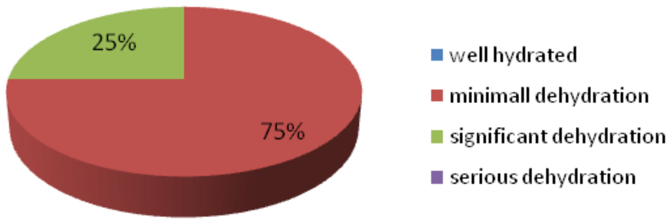


Graph 5.1.63 Morning urine, day 3

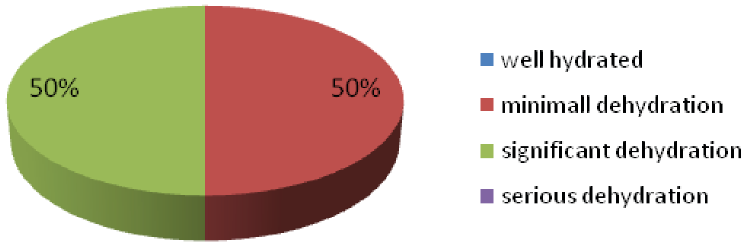


Graph 5.1.64 Urine after game

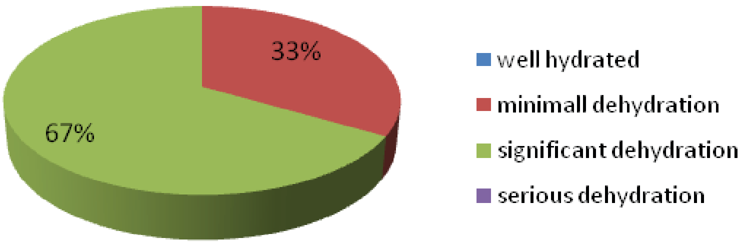
HYDRATATION STATUS -TEAM 8 (BY SPECIFIC GRAVITY)



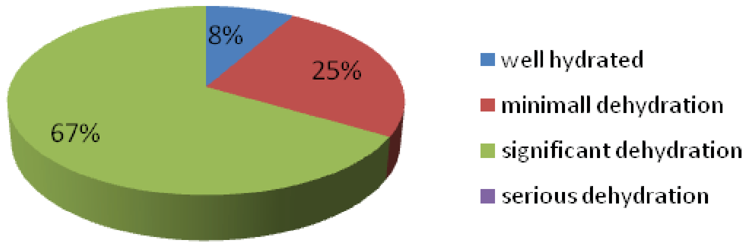
Graph 5.1.65 Morning urine, day 1



Graph 5.1.66 Morning urine, day 2



Graph 5.1.67 Morning urine, day 3

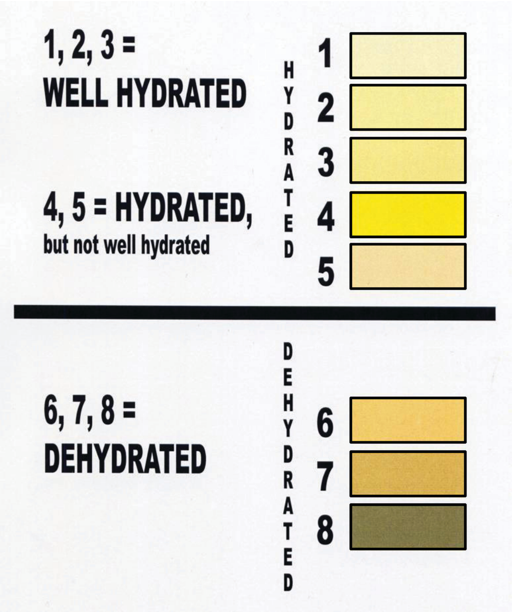


Graph 5.1.68 Urine after game

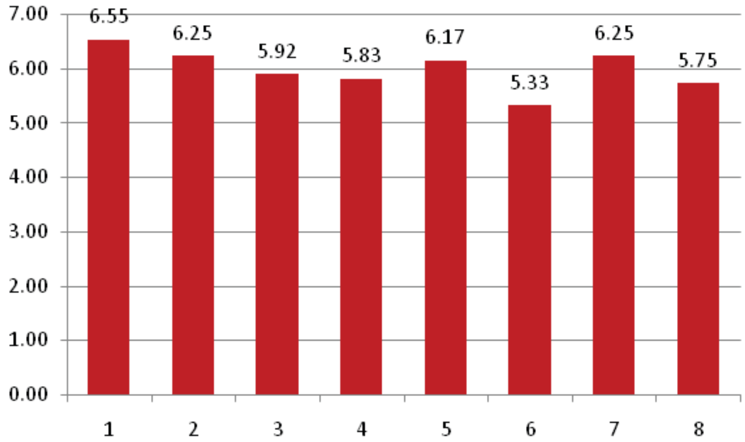
5.2 URINE COLOUR

Urine colour is determined primarily by the amount of urochrome, a break-down product of hemoglobin, present in the sample. Using a scale of eight colours it was concluded that a linear relationship existed between urine colour and both specific gravity and osmolality of the urine and that urine colour can therefore be used in field settings to estimate hydration status (*Armstrong LA. 2005*).

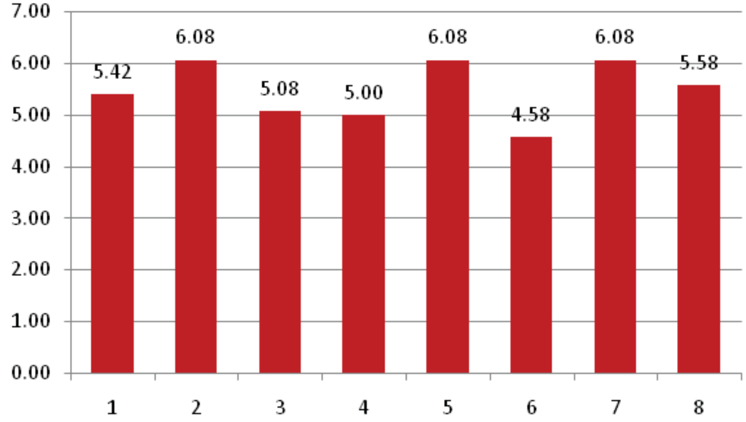
If urine colour matches value from 1 to 2 on scale we are talking about well hydrated status, from 3 to 4 about minimal dehydration, from 5 to 6 about significant dehydration and above 7 about serious dehydration.



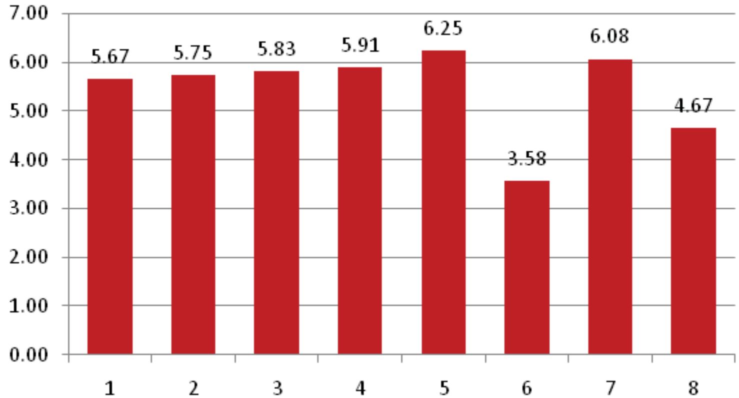
AVERAGE URINE COLOUR BY TEAMS



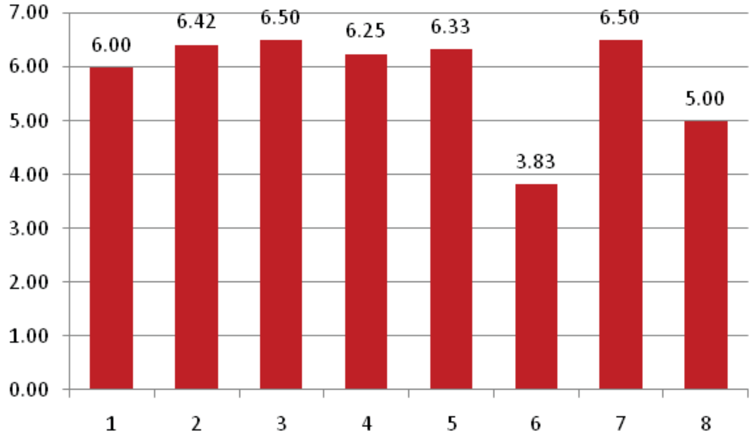
Graph 5.2.1 Day 1



Graph 5.2.2 Day 2

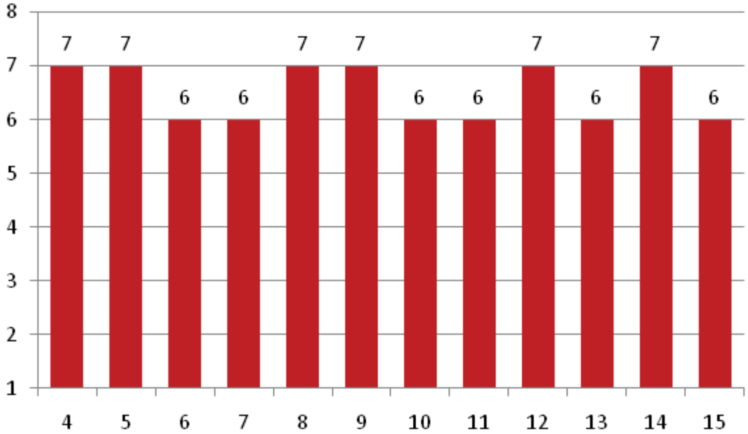


Graph 5.2.3 Day 3

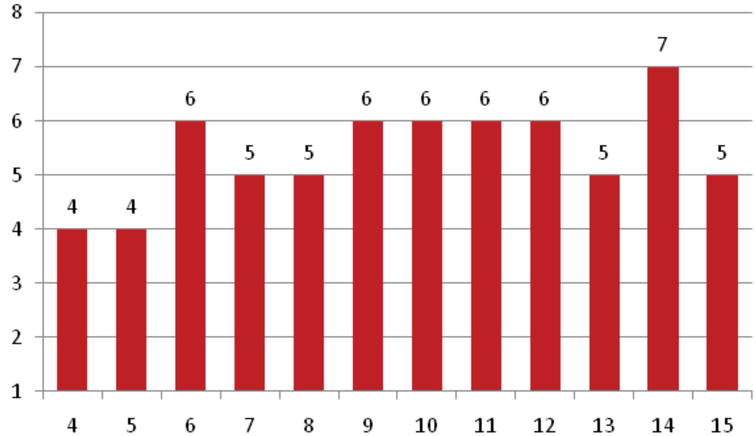


Graph 5.2.4 After game

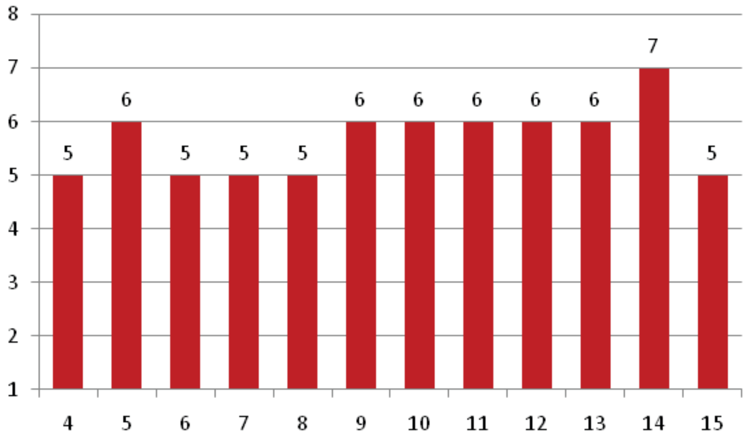
AVERAGE MORNING URINE COLOUR BY PLAYERS



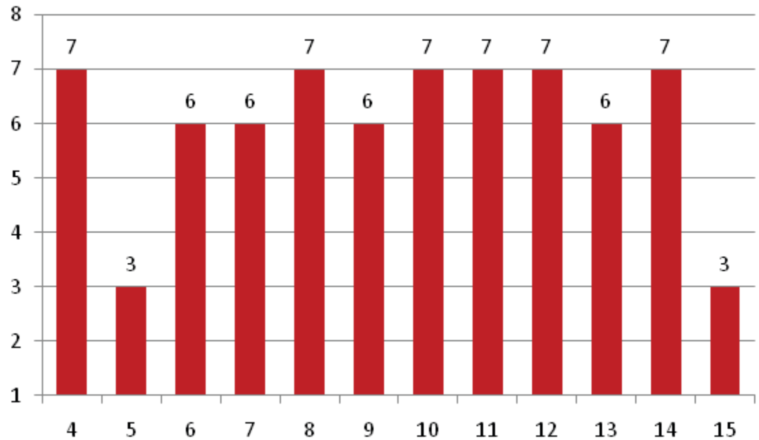
Graph 5.2.5 Team 1, Day 1



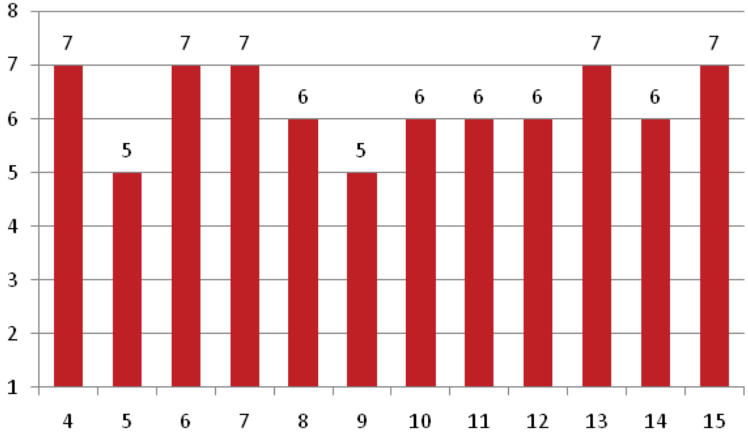
Graph 5.2.6 Team 1, Day 2



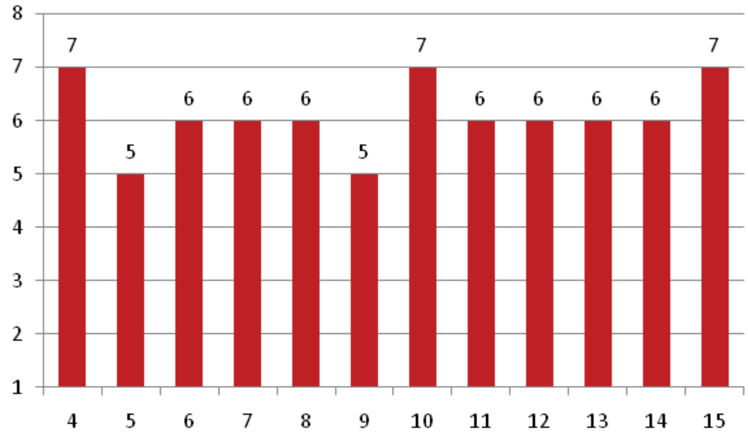
Graph 5.2.7 Team 1, Day 3



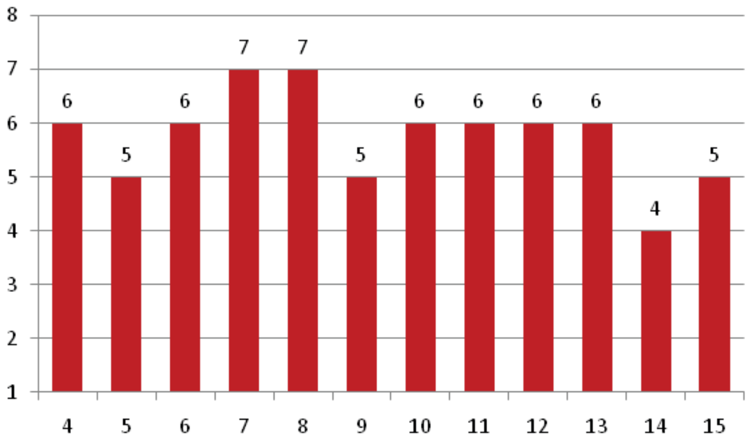
Graph 5.2.8 Team 1, after game



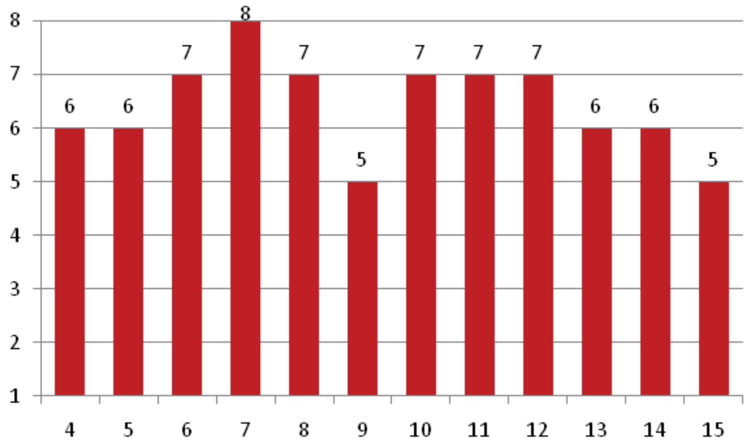
Graph 5.2.9 Team 2, Day 1



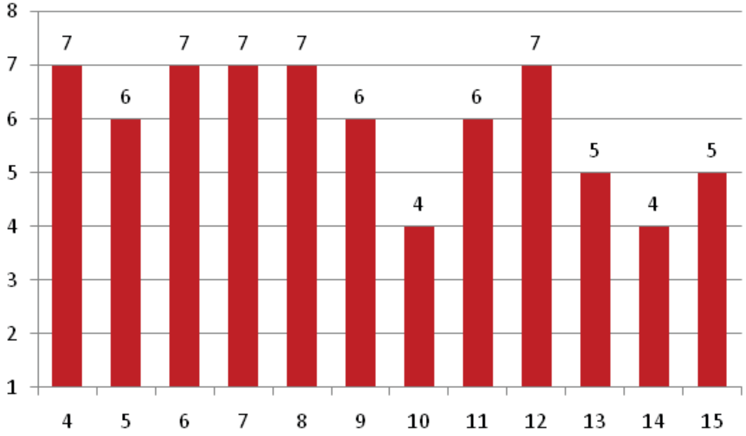
Graph 5.2.10 Team 2, Day 2



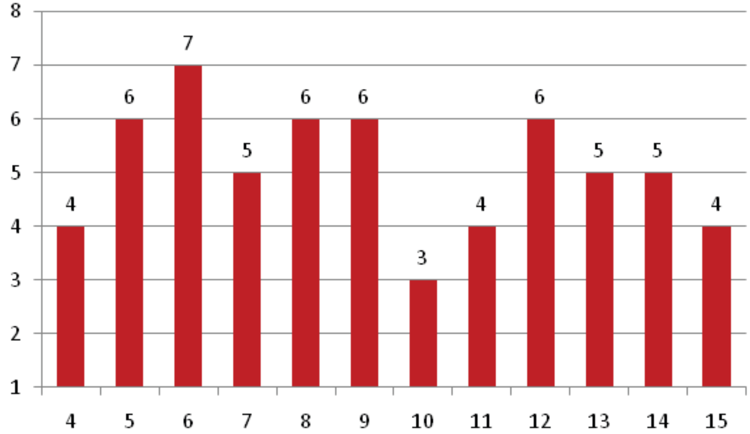
Graph 5.2.11 Team 2, Day 3



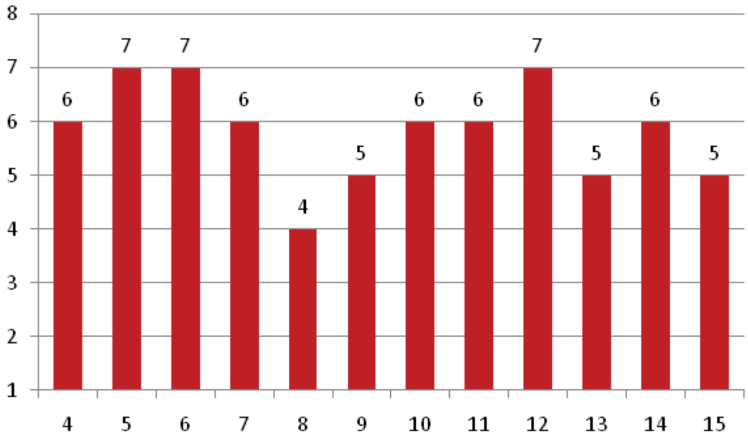
Graph 5.2.12 Team 2, After game



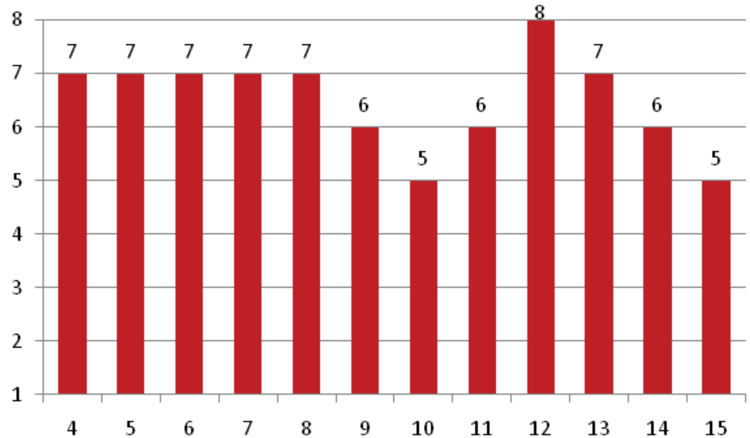
Graph 5.2.13 Team 3, Day 1



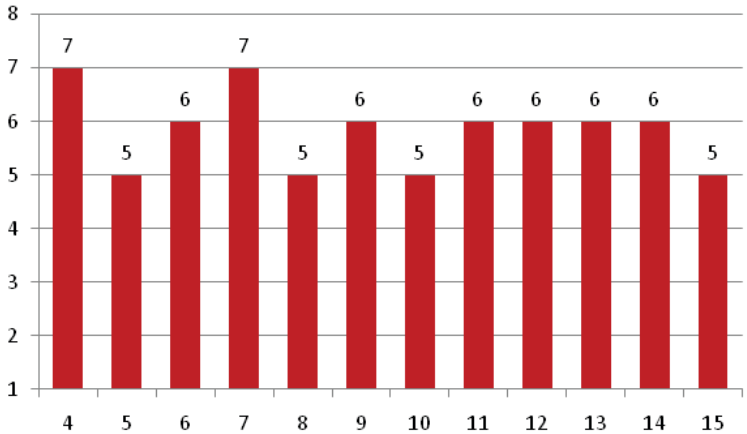
Graph 5.2.14 Team 3, Day 2



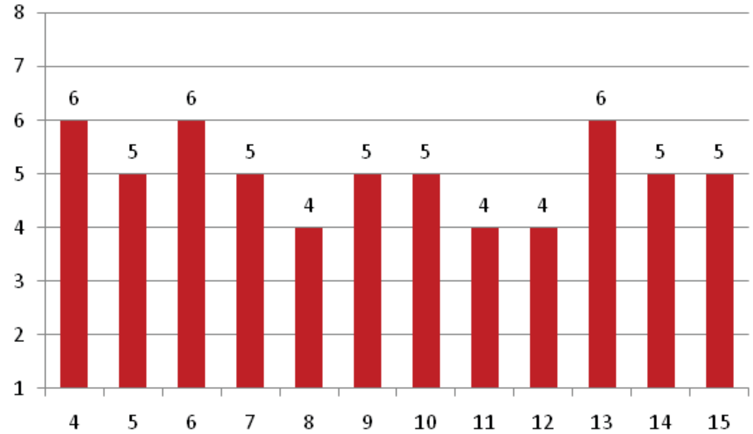
Graph 5.2.15 Team 3, Day 3



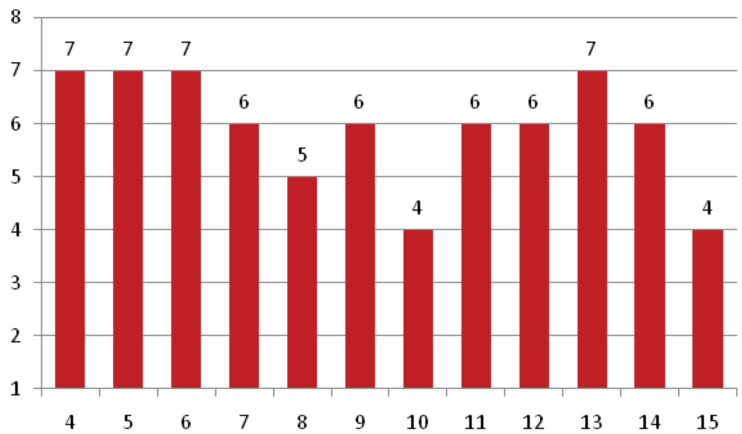
Graph 5.2.16 Team 3, After game



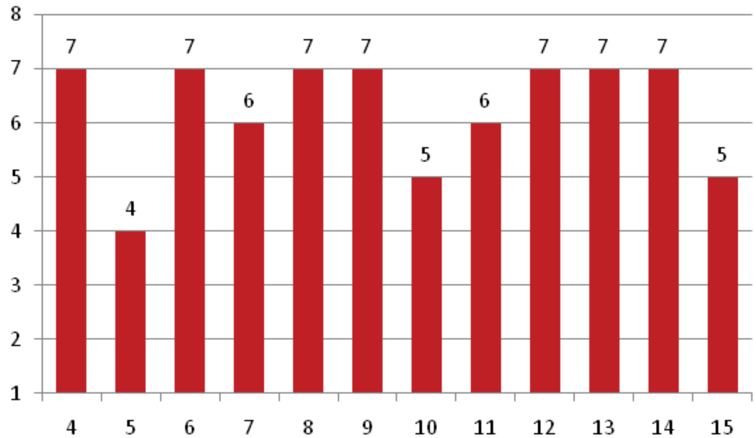
Graph 5.2.17 Team 4, Day 1



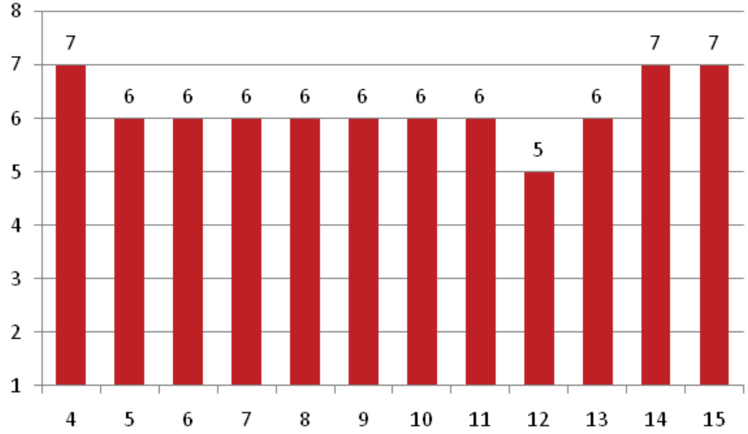
Graph 5.2.18 Team 4, Day 2



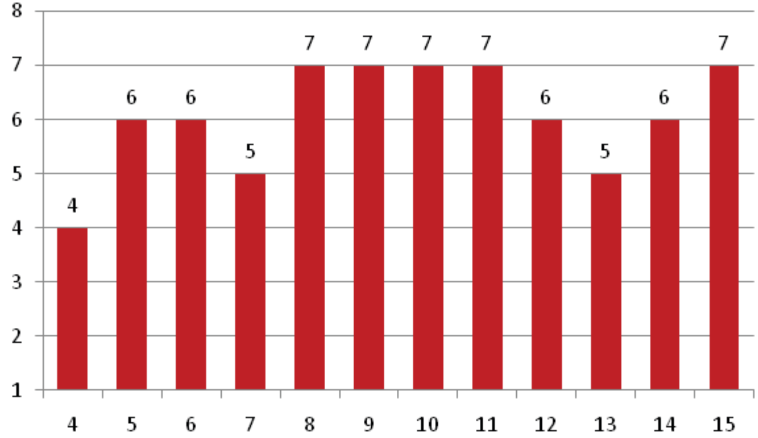
Graph 5.2.19 Team 4, Day 3



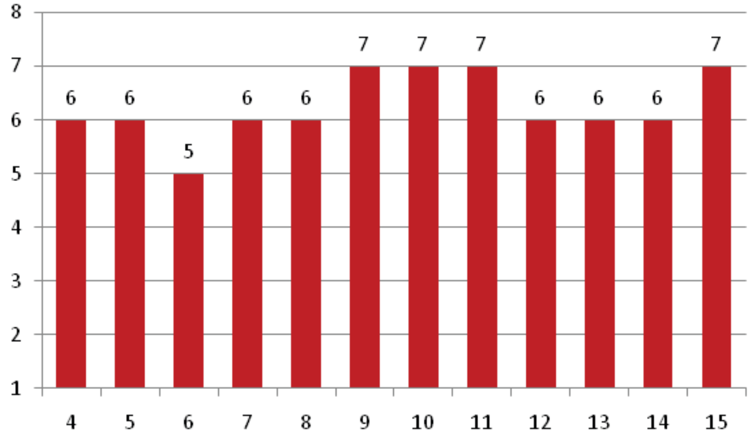
Graph 5.2.20 Team 4, After game



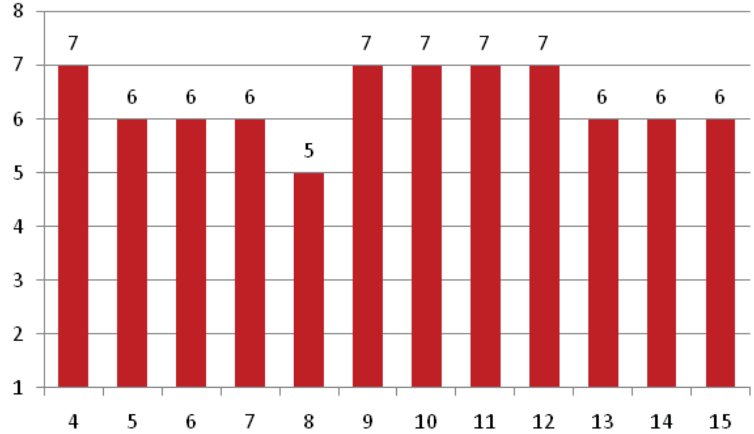
Graph 5.2.21 Team 5, Day 1



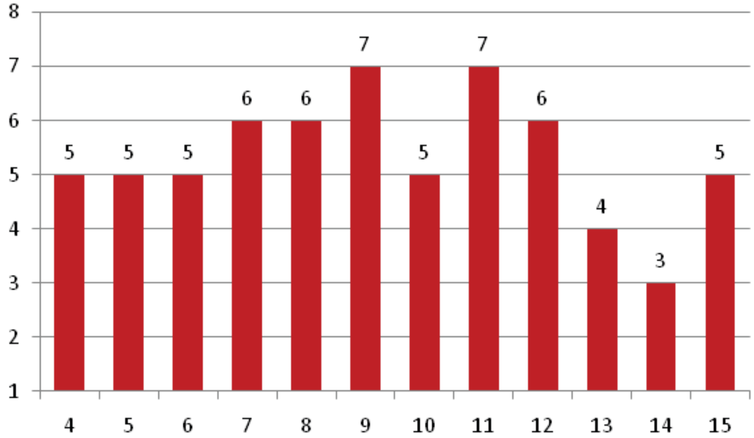
Graph 5.2.22 Team 5, Day 2



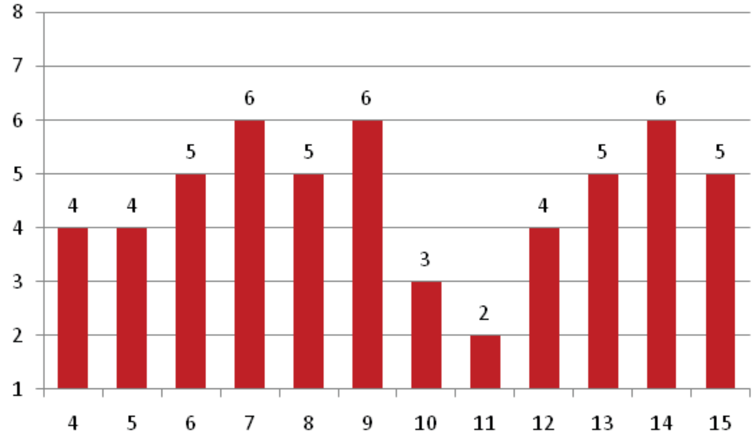
Graph 5.2.23 Team 5, Day 3



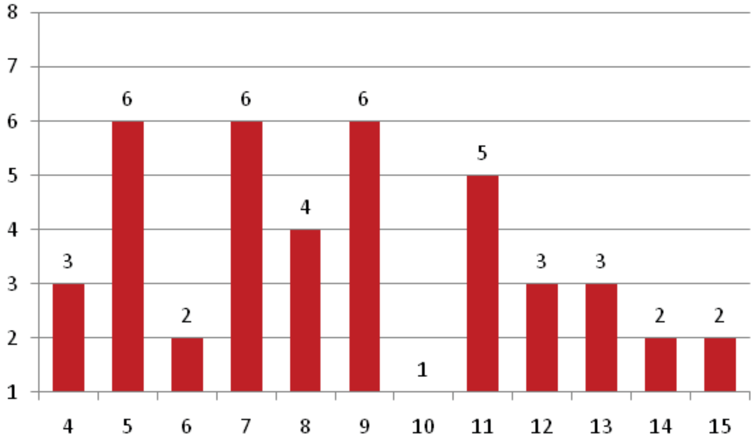
Graph 5.2.24 Team 5, After game



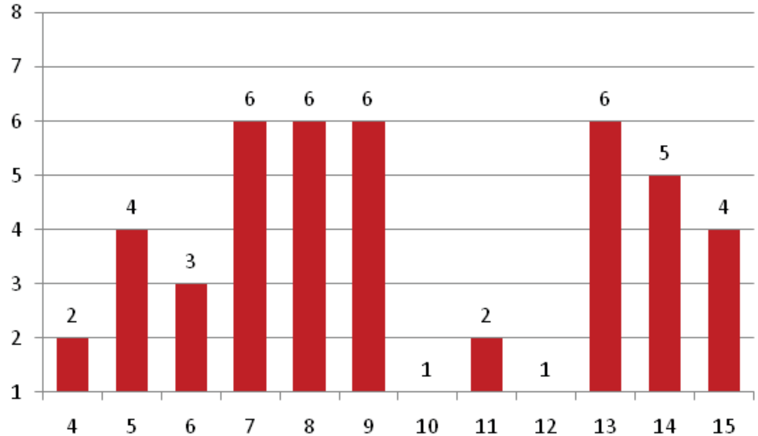
Graph 5.2.25 Team 6, Day 1



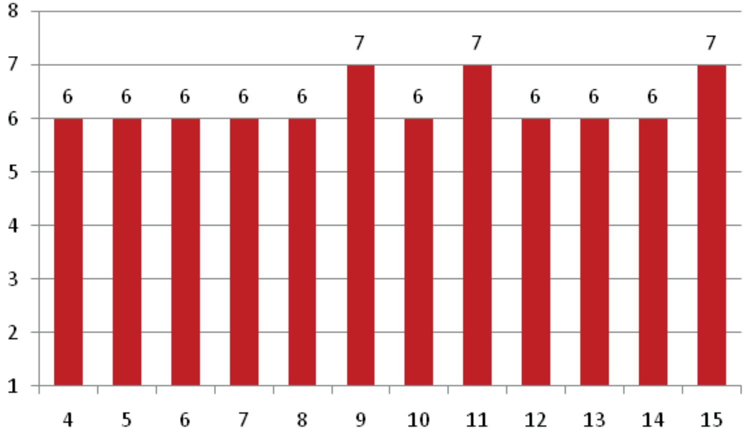
Graph 5.2.26 Team 6, Day 2



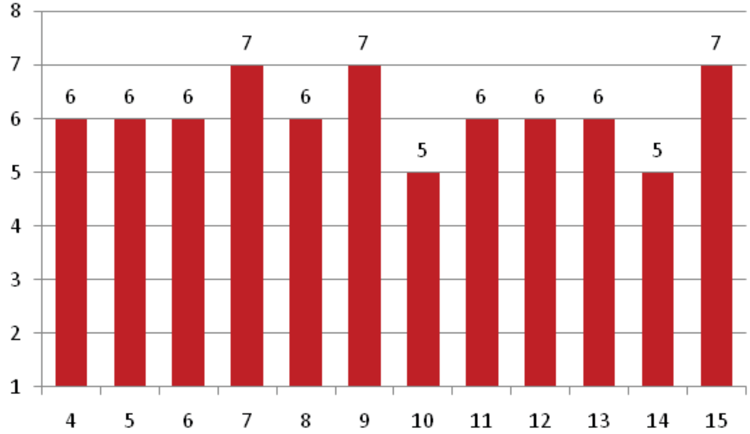
Graph 5.2.27 Team 6, Day 3



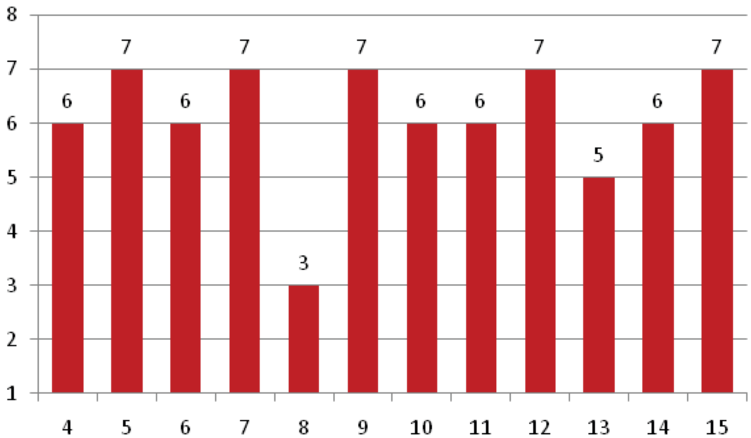
Graph 5.2.28 Team 6, After game



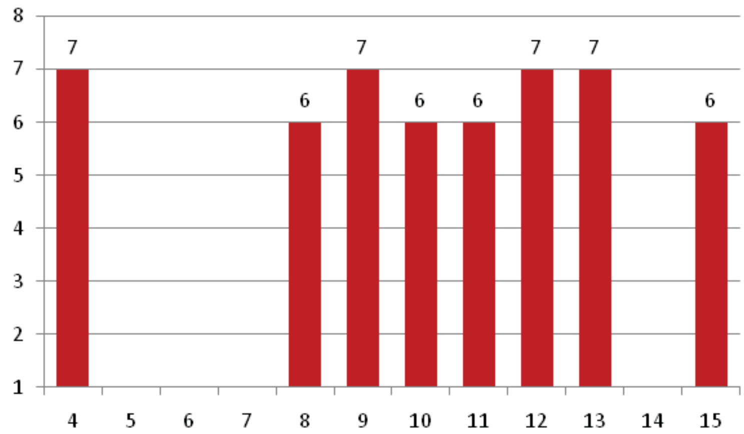
Graph 5.2.29 Team 7, Day 1



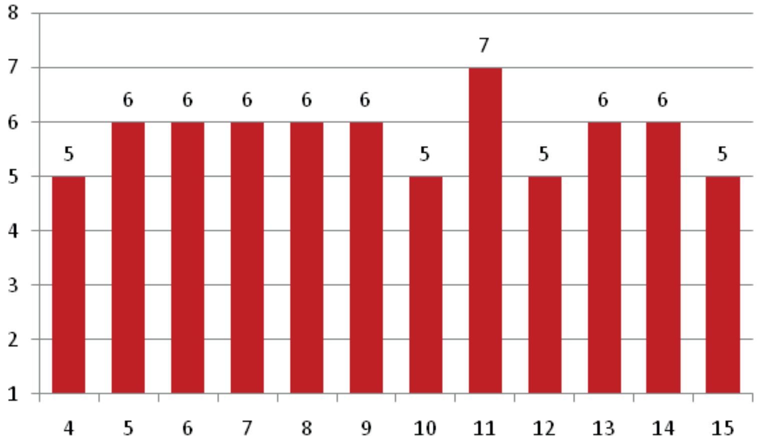
Graph 5.2.30 Team 7, Day 2



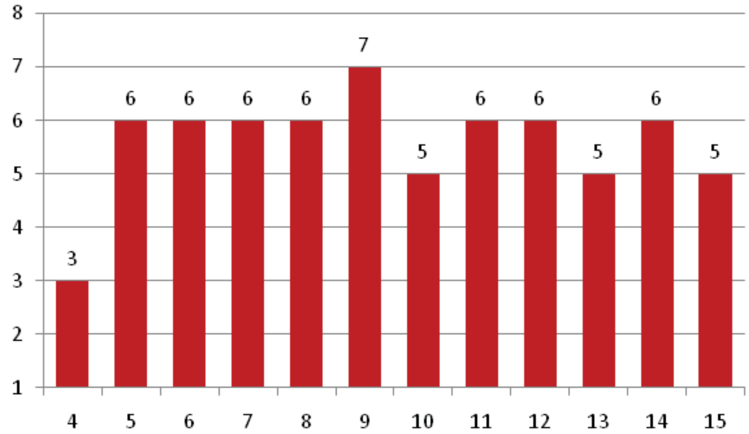
Graph 5.2.31 Team 7, Day 3



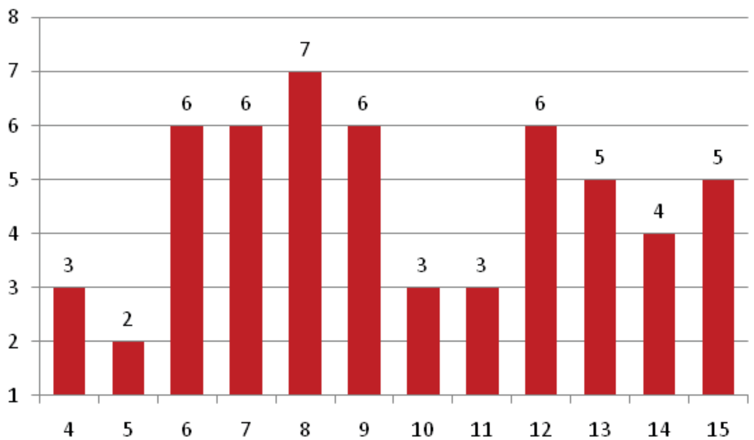
Graph 5.2.32 Team 7, After game



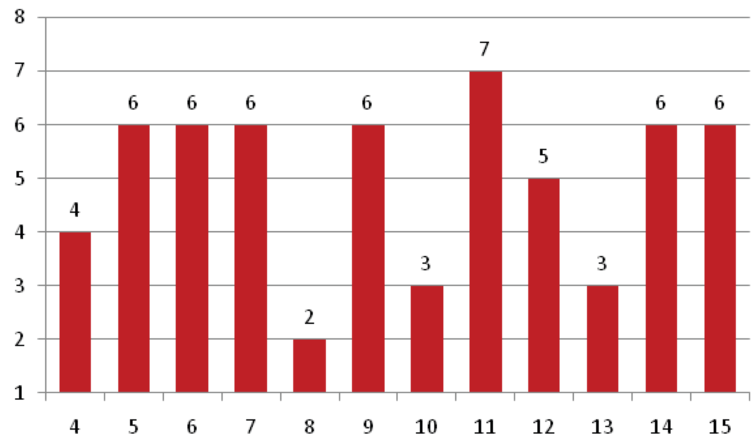
Graph 5.2.33 Team 8, Day 1



Graph 5.2.34 Team 8, Day 2

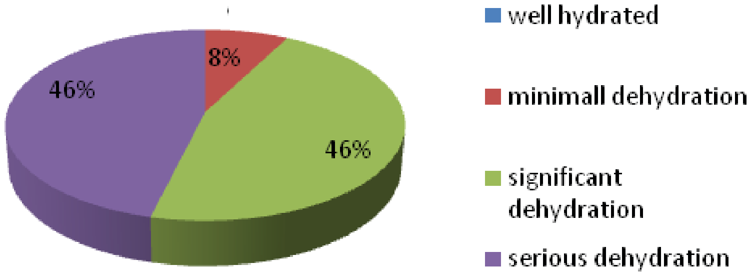


Graph 5.2.35 Team 8, Day 3

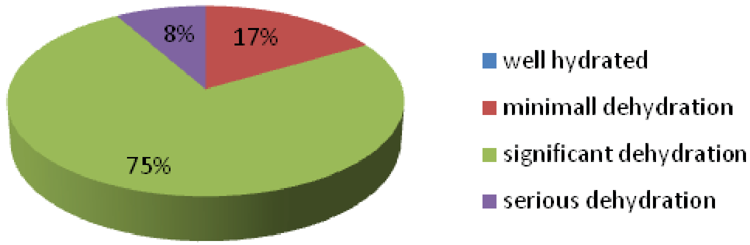


Graph 5.2.36 Team 8, After game

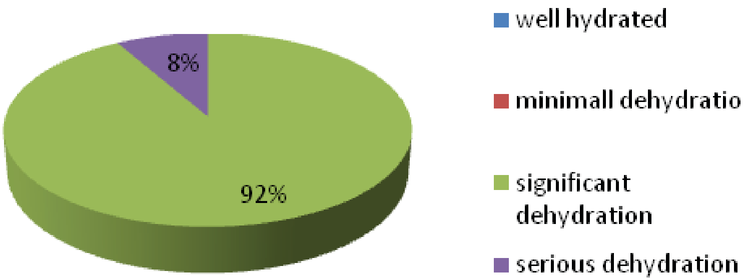
HYDRATATION STATUS - TEAM 1 (BY URINE COLOR)



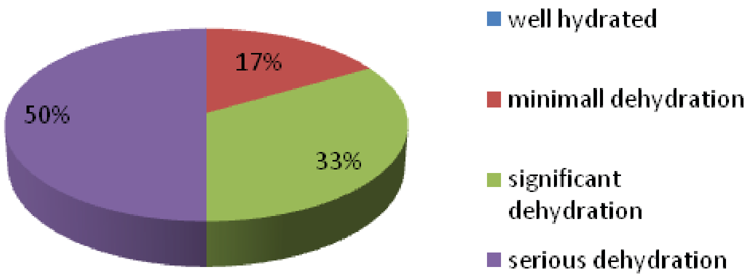
Graph 5.2.37 Morning urine, Day 1



Graph 5.2.38 Morning urine, Day 2

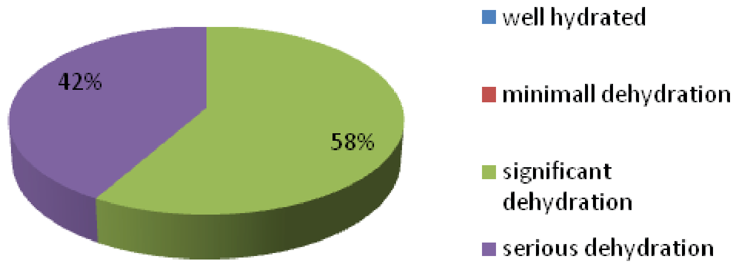


Graph 5.2.39 Morning urine, Day 3

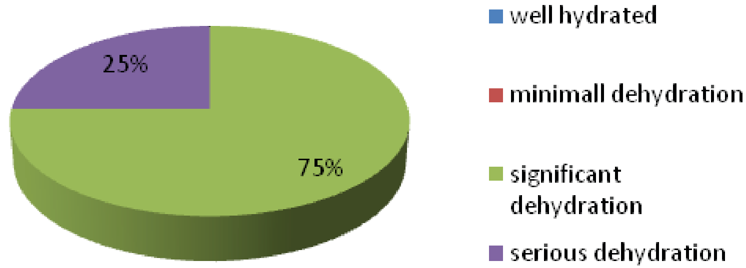


Graph 5.2.40 Urine after game

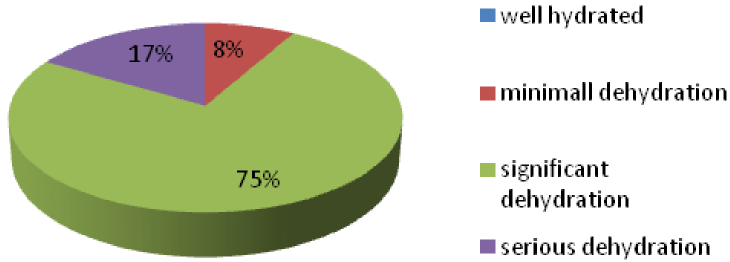
HYDRATATION STATUS - TEAM 2 (BY URINE COLOR)



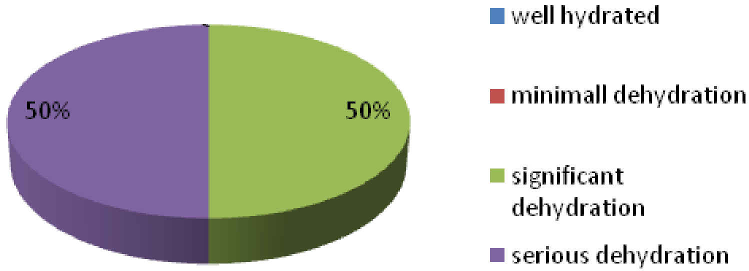
Graph 5.2.41 Morning urine, Day 1



Graph 5.2.42 Morning urine, Day 2

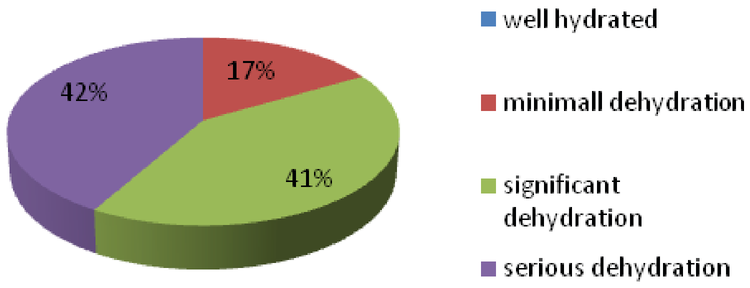


Graph 5.2.43 Morning urine, Day 3

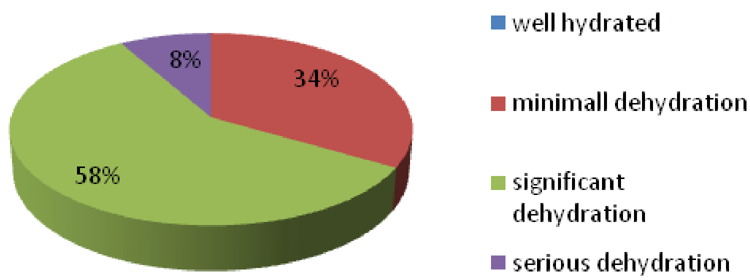


Graph 5.2.44 Urine after game

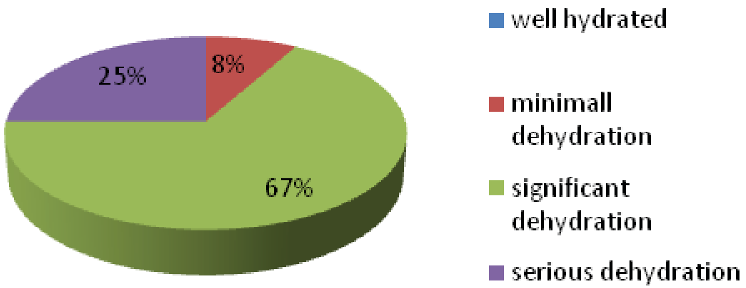
HYDRATATION STATUS - TEAM 3 (BY URINE COLOR)



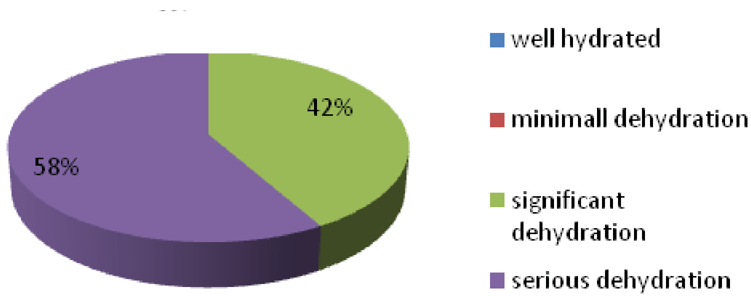
Graph 5.2.45 Morning urine, Day 1



Graph 5.2.46 Morning urine, Day 2

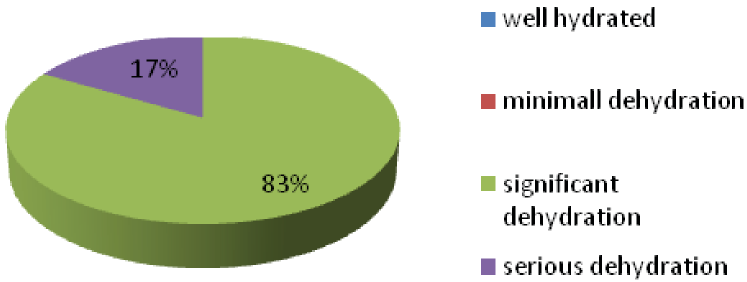


Graph 5.2.47 Morning urine, Day 3

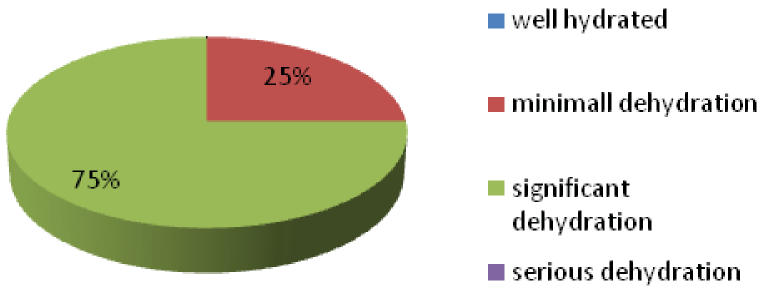


Graph 5.2.48 Urine after game

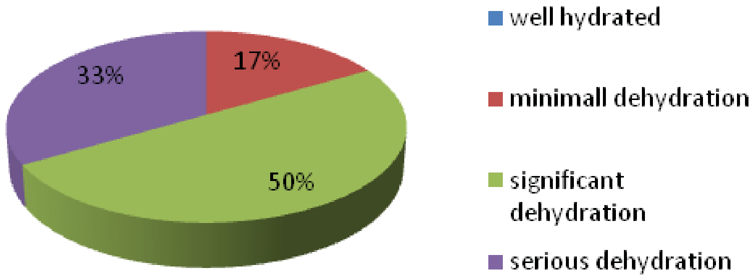
HYDRATATION STATUS - TEAM 4 (BY URINE COLOR)



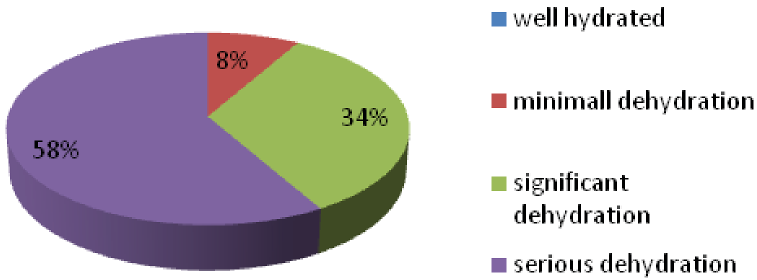
Graph 5.2.49 Morning urine, Day 1



Graph 5.2.50 Morning urine, Day 2

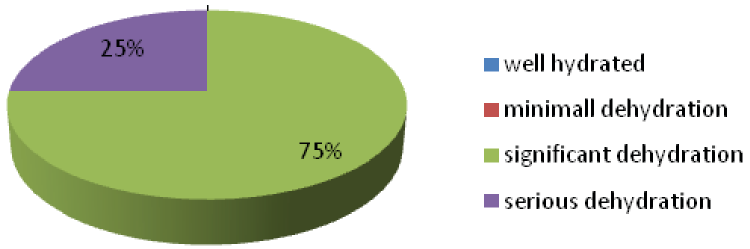


Graph 5.2.51 Morning urine, Day 3

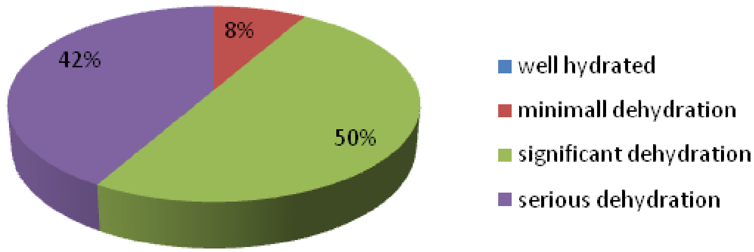


Graph 5.2.52 Urine after game

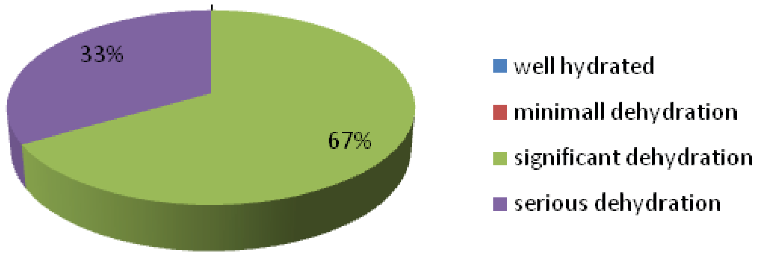
HYDRATATION STATUS - TEAM 5 (BY URINE COLOR)



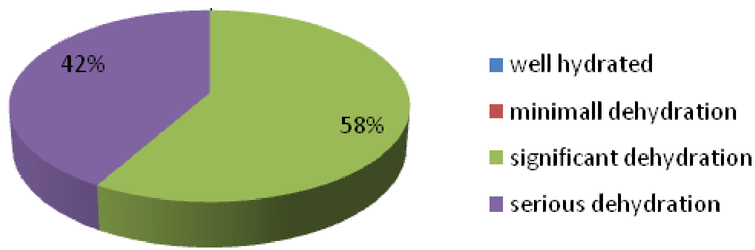
Graph 5.2.53 Morning urine, Day 1



Graph 5.2.54 Morning urine, Day 2

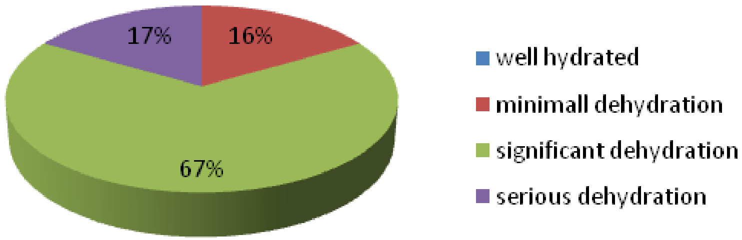


Graph 5.2.55 Morning urine, Day 3

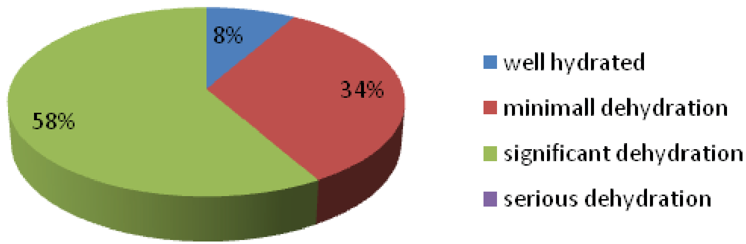


Graph 5.2.56 Urine after game

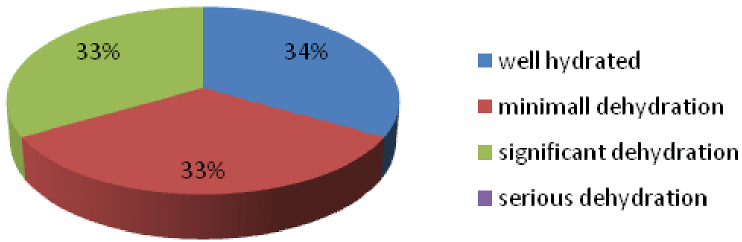
HYDRATATION STATUS - TEAM 6 (BY URINE COLOR)



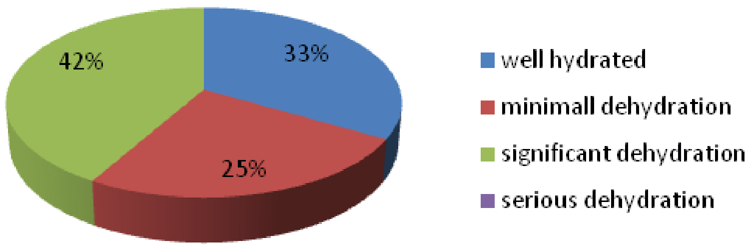
Graph 5.2.57 Morning urine, Day 1



Graph 5.2.58 Morning urine, Day 2

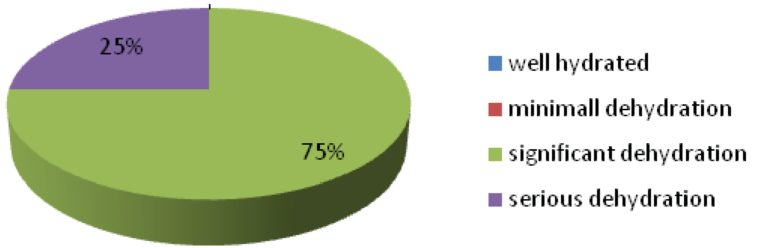


Graph 5.2.59 Morning urine, Day 3

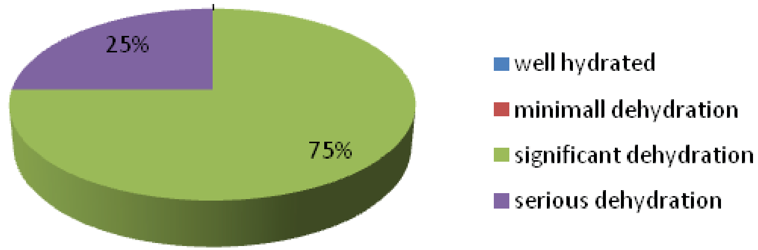


Graph 5.2.60 Urine after game

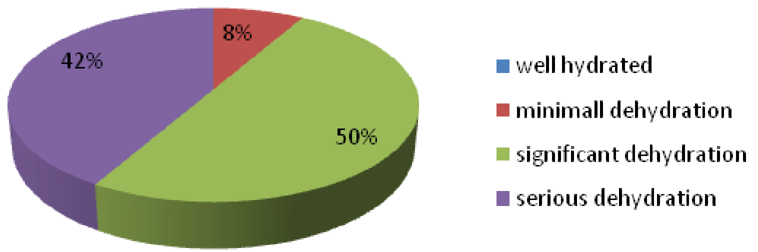
HYDRATATION STATUS - TEAM 7 (BY URINE COLOR)



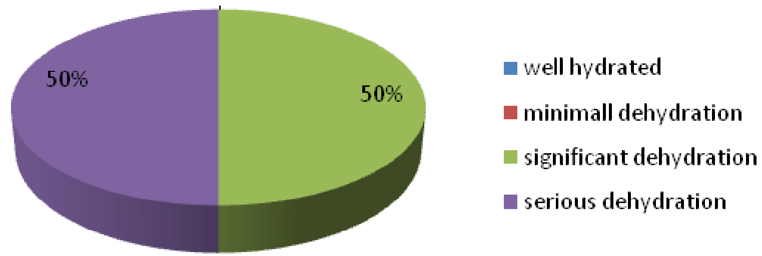
Graph 5.2.61 Morning urine, Day 1



Graph 5.2.62 Morning urine, Day 2

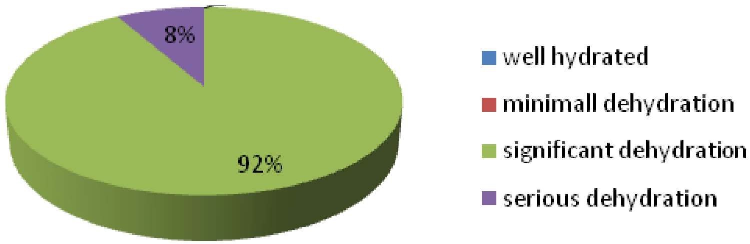


Graph 5.2.63 Morning urine, Day 3

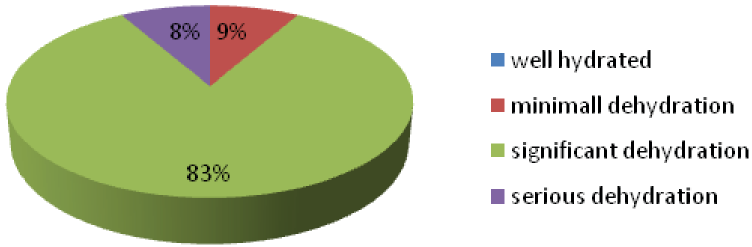


Graph 5.2.64 Urine after game

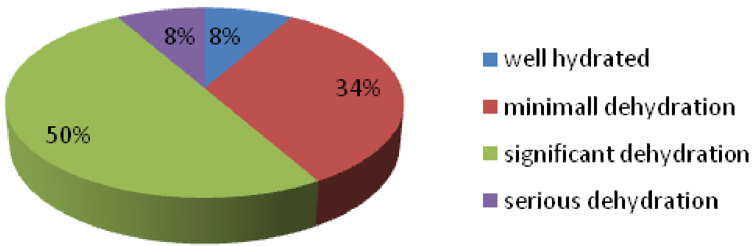
HYDRATATION STATUS - TEAM 8 (BY URINE COLOR)



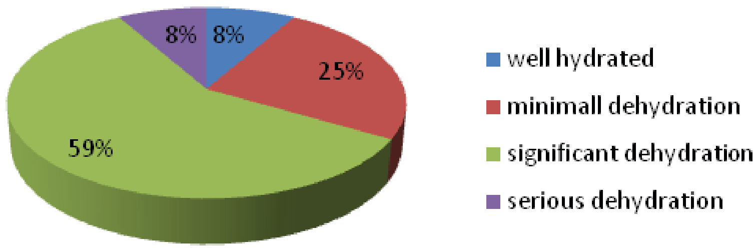
Graph 5.2.65 Morning urine, Day 1



Graph 5.2.66 Morning urine, Day 2



Graph 5.2.67 Morning urine, Day 3



Graph 5.2.68 Urine after game

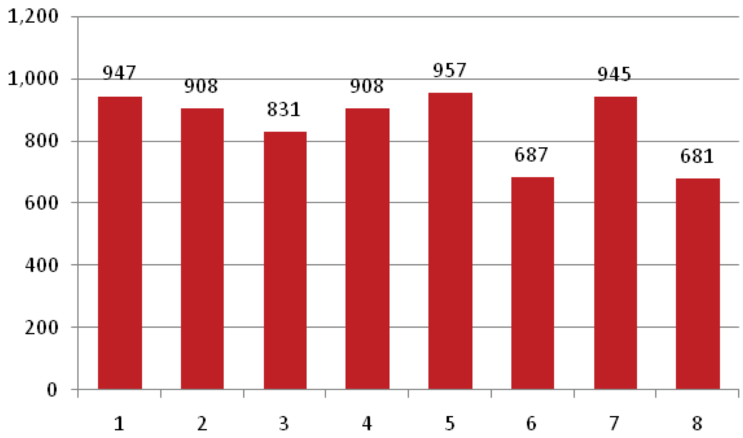
5.3 URINE OSMOLALITY

Although there is no „gold standard" for assessment of hydration status, it appears that changes in body weight, along with urine osmolality, specific gravity, conductivity and color are among the most widely used indices. Furthermore, they provide reasonable results, especially when the analysis is based on the first morning urine sample (*Kavouras SA. 2002*).

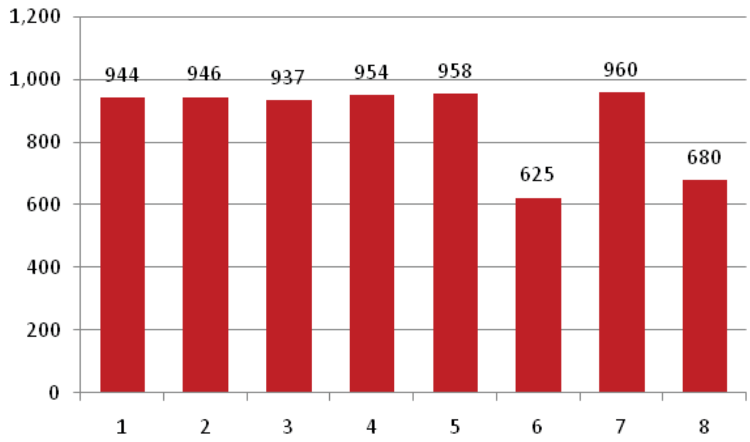
Armstrong et al. (1998) demonstrated that urine specific gravity (as measured with a refractometer) and urine osmolality (as measured with an osmometer) may be used interchangeably. The correlation (r2) of these measurements was 0.96 (*Osterberg K. Basketball and Hydration*).

Calculation of an individual's pre-exercise urine osmolality, and also their Urine Specific Gravity levels have been used as methods of determining pre-exercise hydration status (Maughan & Shirreffs 1997; Shirreffs et al. 2005). [5] If an individual's pre-exercise urine osmolality is less than 900 mOsmol/kg, then they are considered to be in a euhydrated state, while a USG greater than 1.025 g/ml classes an individual as dehydrated. However, the ACSM's position stand concerning exercise and fluid replacement (Sawka et al. 2007) suggests that a pre-exercise urine osmolality of less than 700 mOsmol/kg is indicative of euhydration (*Sawka MN, Burke LM, et.al. 2007*).

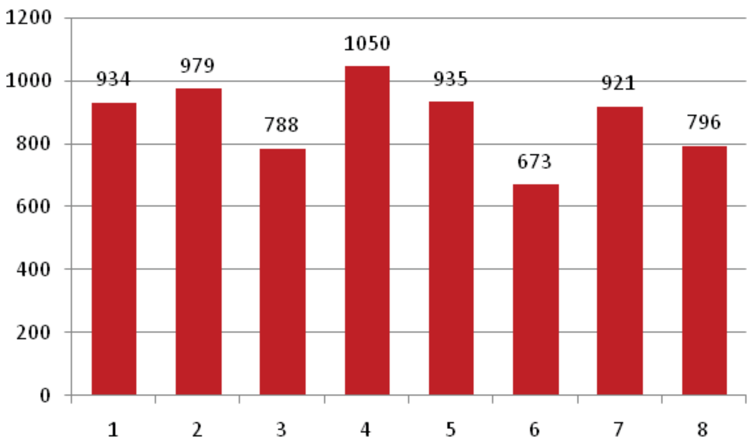
AVERAGE URINE OSMOLALITY BY TEAMS



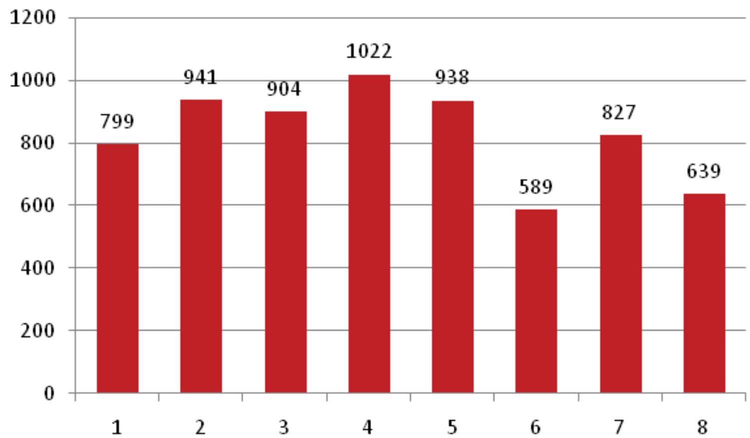
Graph 5.3.1 Day 1



Graph 5.3.2 Day 2

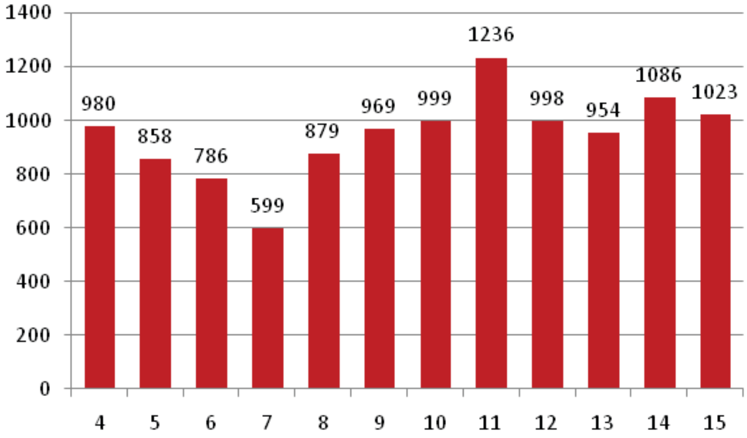


Graph 5.3.3 Day 3

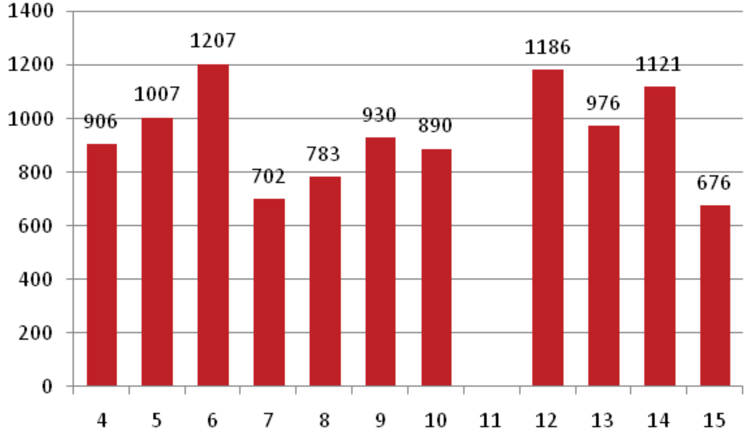


Graph 5.3.4 After game

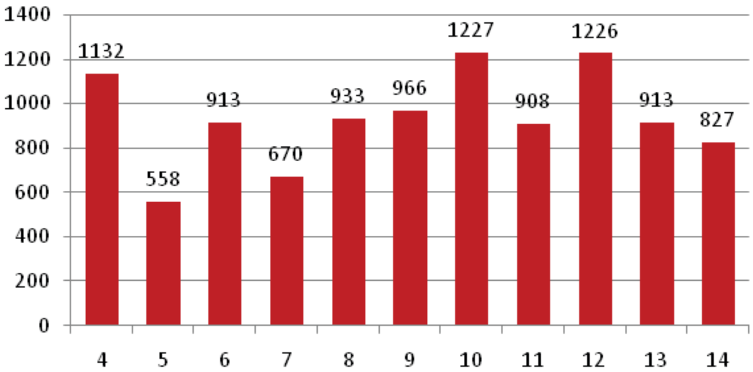
AVERAGE URINE OSMOLALITY BY PLAYERS



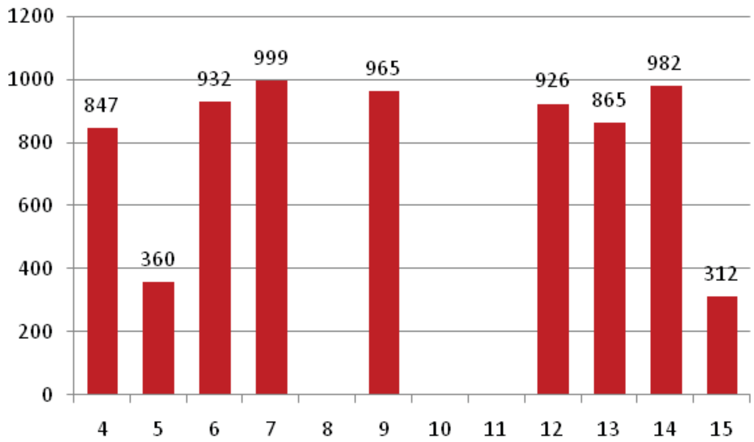
Graph 5.3.5 Team 1, Day 1



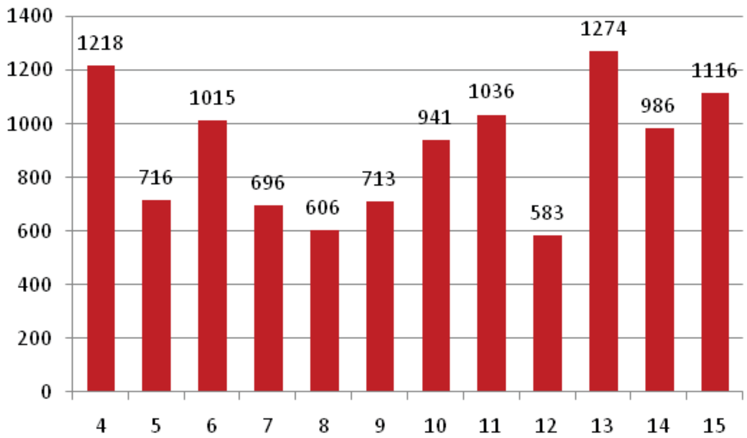
Graph 5.3.6 Team 1, Day 2



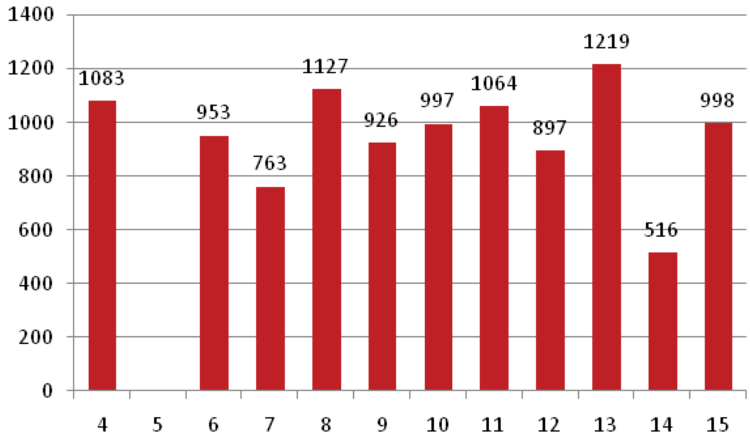
Graph 5.3.7 Team 1, Day 3



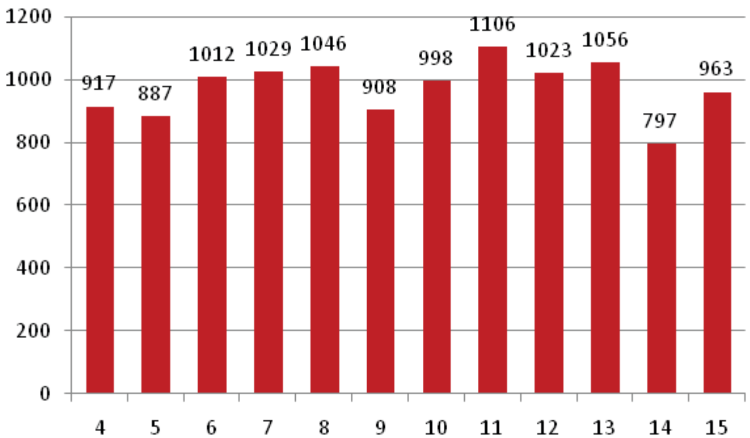
Graph 5.3.8 Team 1, After game



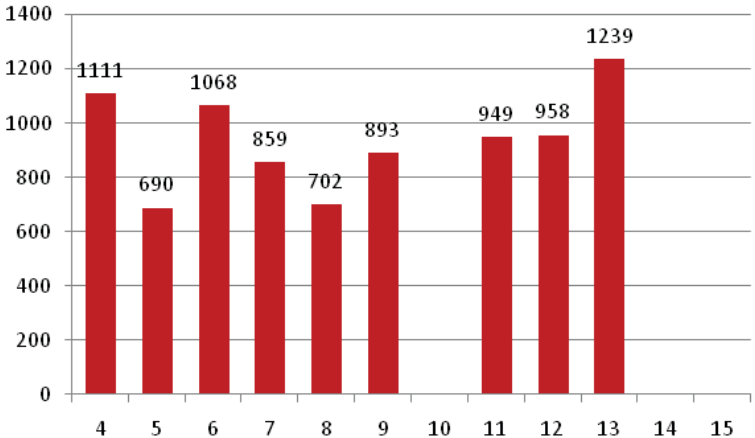
Graph 5.3.9 Team 2, Day 1



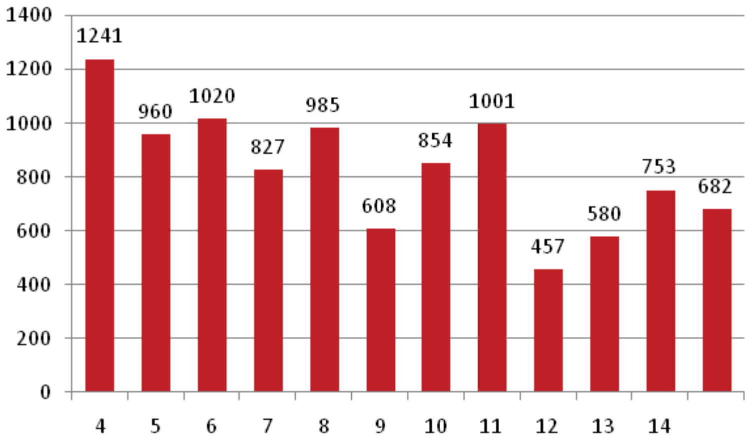
Graph 5.3.10 Team 2, Day 2



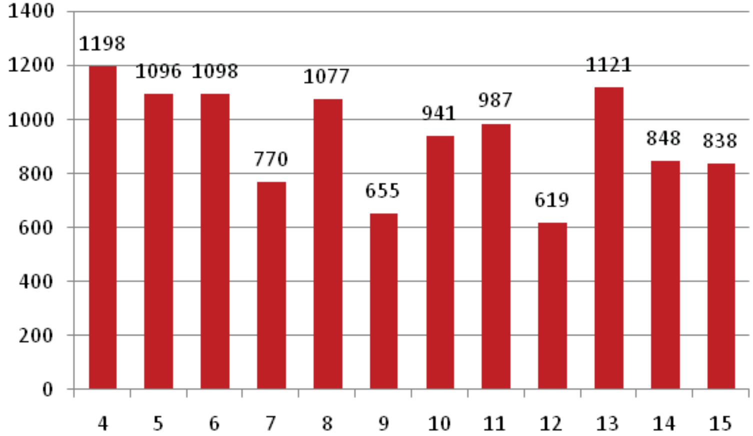
Graph 5.3.11 Team 2, Day 3



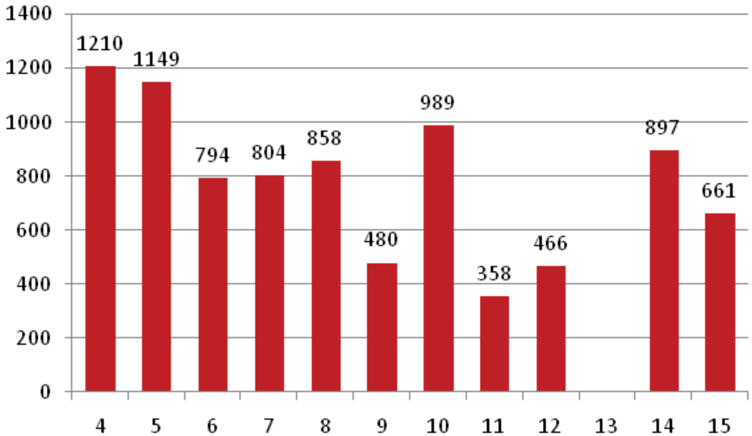
Graph 5.3.12 Team 2, After game



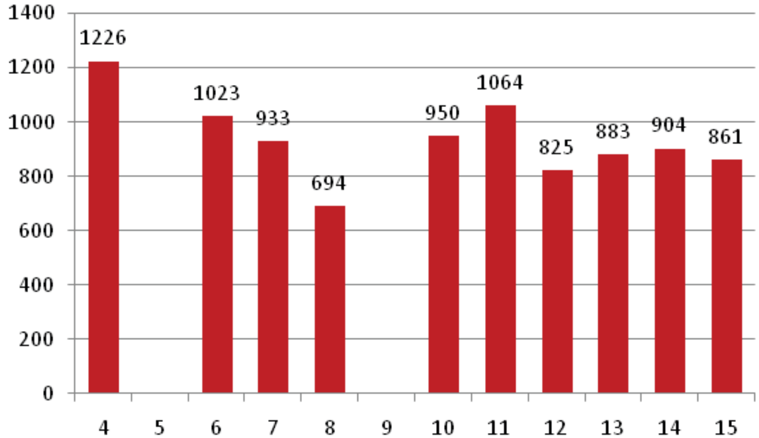
Graph 5.3.13 Team 3, Day 1



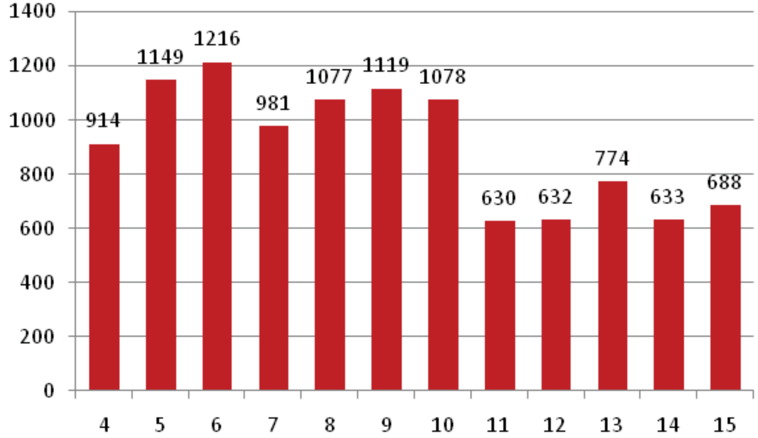
Graph 5.3.14 Team 3, Day 2



Graph 5.3.15 Team 3, Day 3



Graph 5.3.16 Team 3, After game



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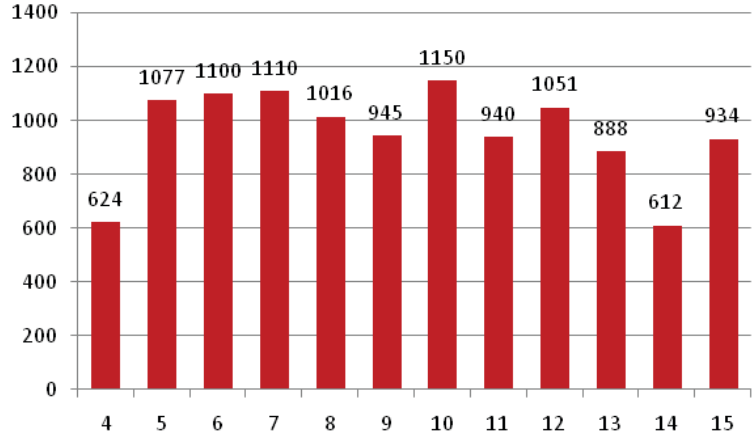
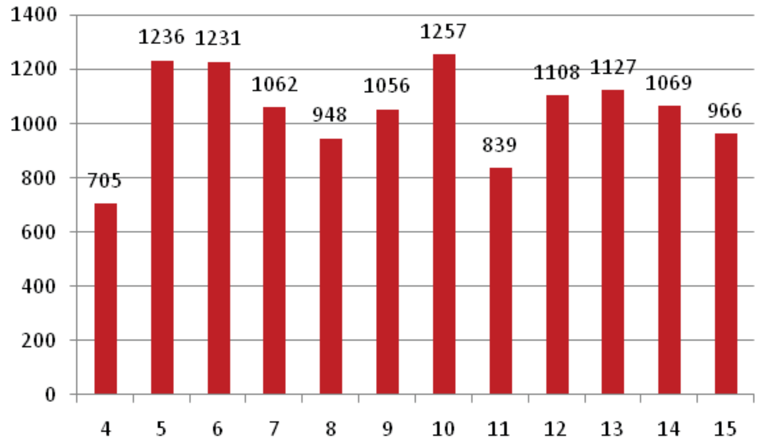
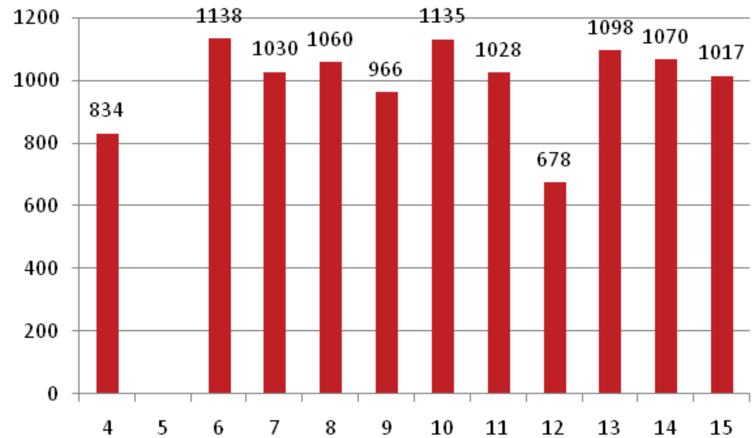


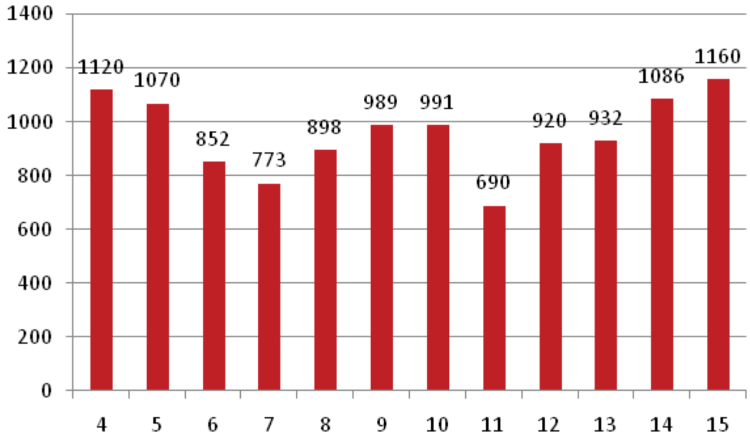
Graph 5.3.18 Team 4, Day 2



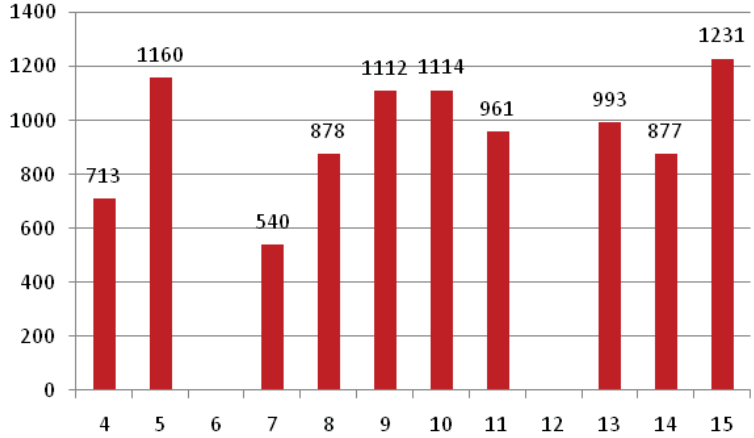
Graph 5.3.19 Team 4, Day 3



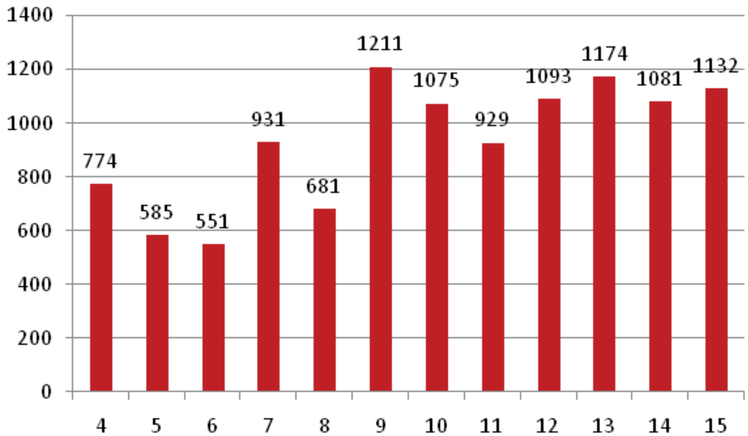
Graph 5.3.20 Team 4, After game



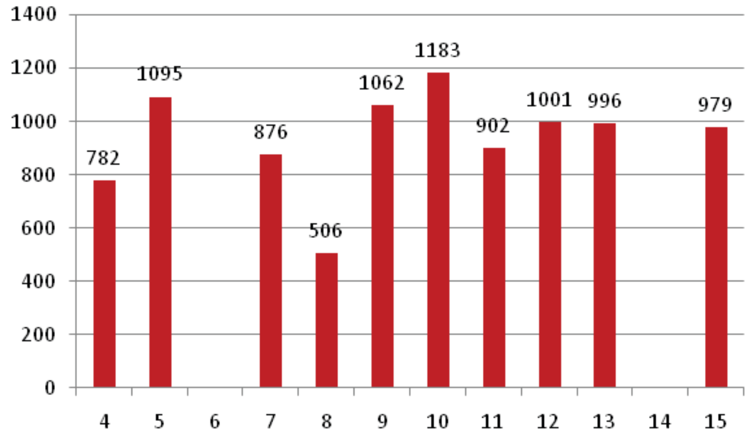
Graph 5.3.21 Team 5, Day 1



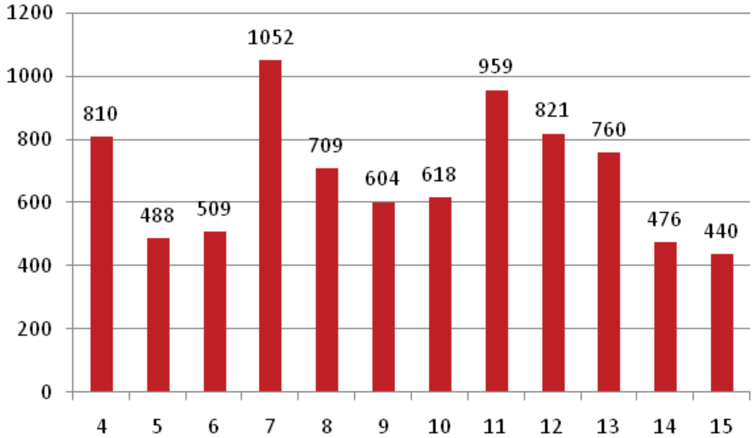
Graph 5.3.22 Team 5, Day 2



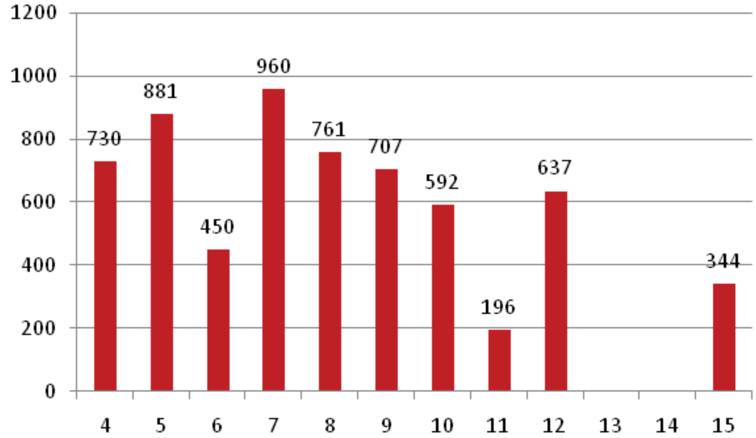
Graph 5.3.23 Team 5, Day 3



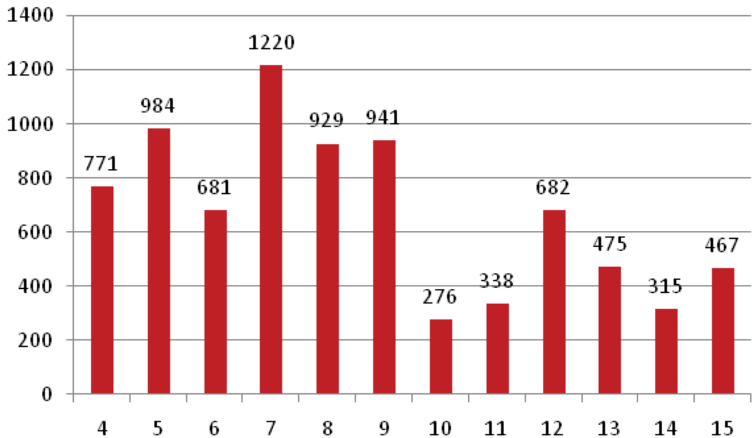
Graph 5.3.24 Team 5, After game



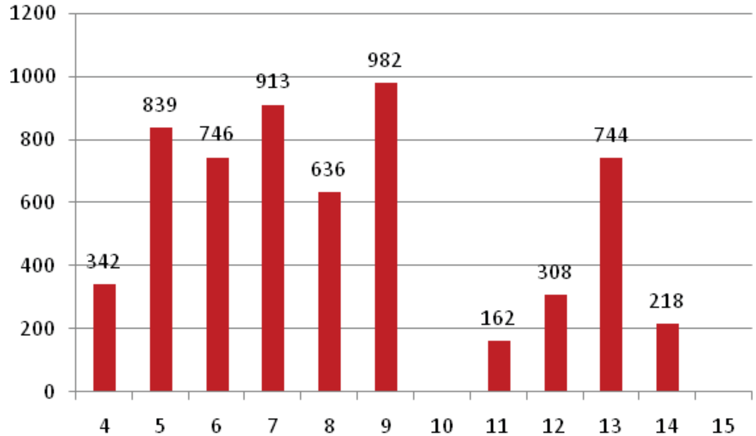
Graph 5.3.25 Team 6, Day 1



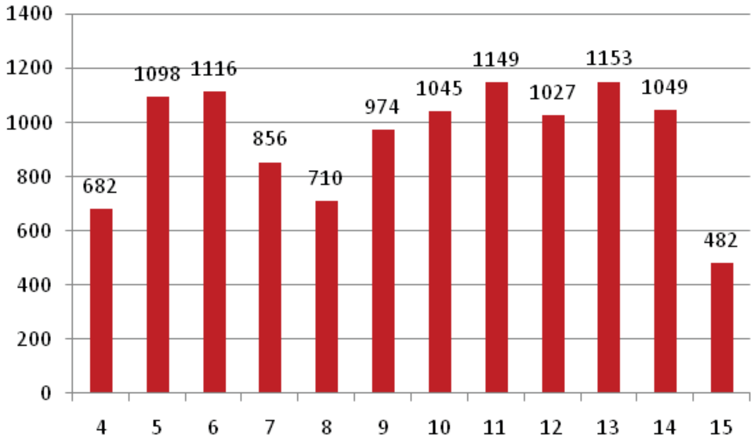
Graph 5.3.26 Team 6, Day 2



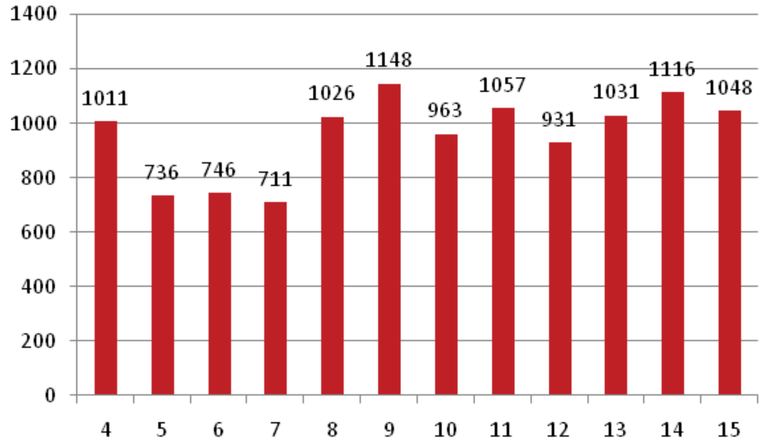
Graph 5.3.27 Team 6, Day 3



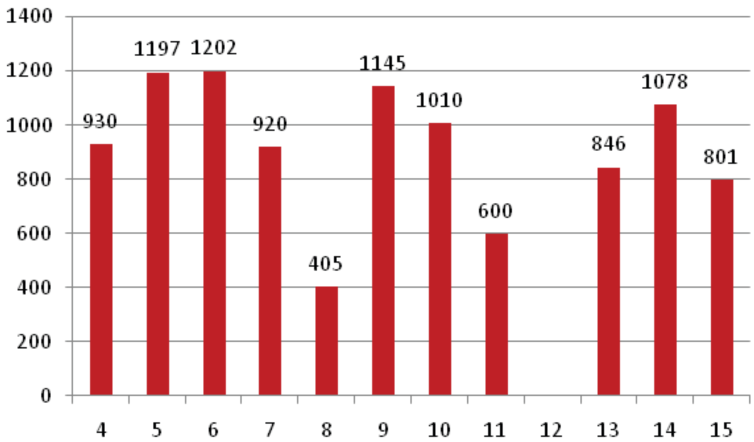
Graph 5.3.28 Team 6, After game



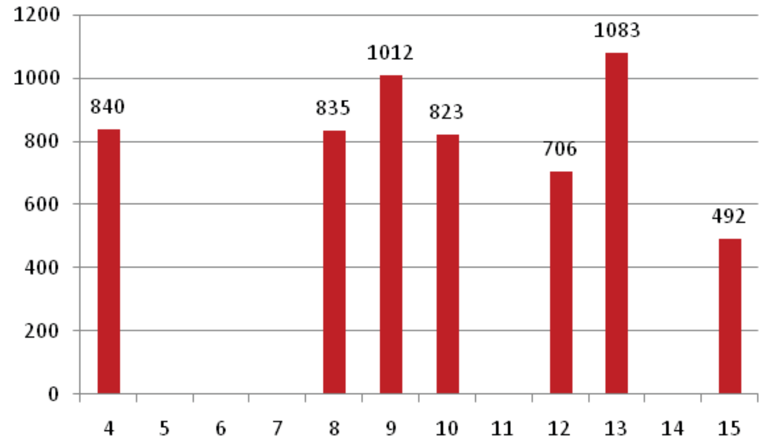
Graph 5.3.29 Team 7, Day 1



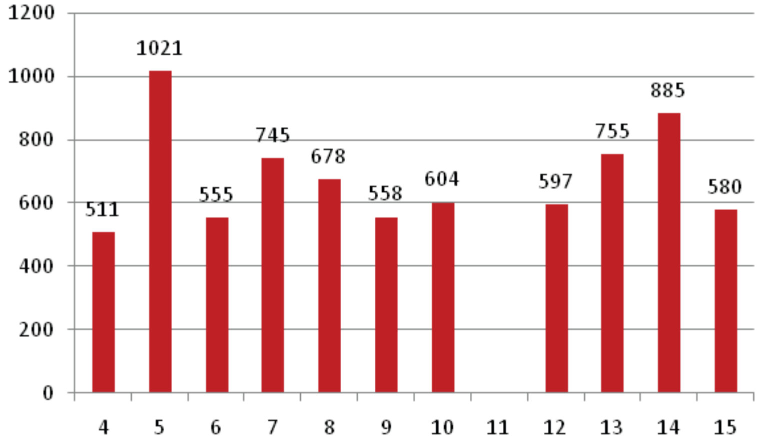
Graph 5.3.30 Team 7, Day 2



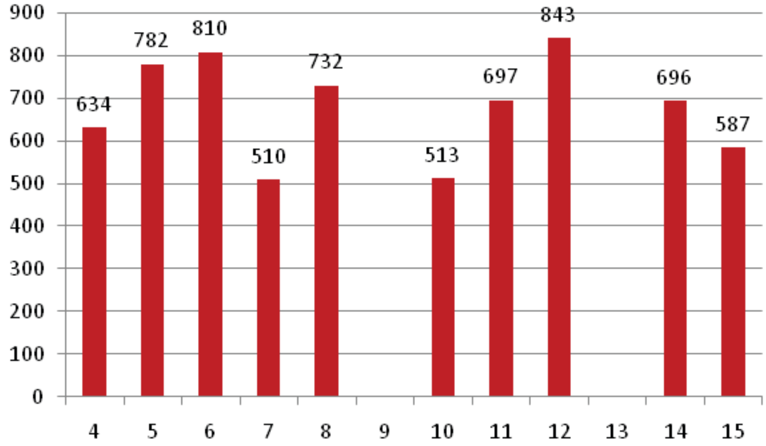
Graph 5.3.31 Team 7, Day 3



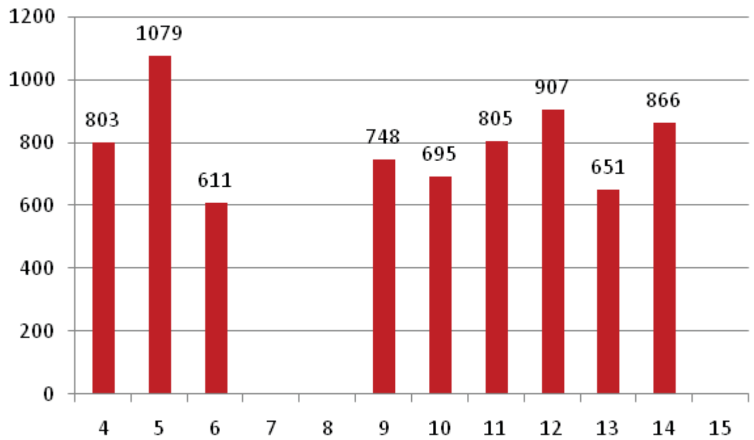
Graph 5.3.32 Team 7, After game



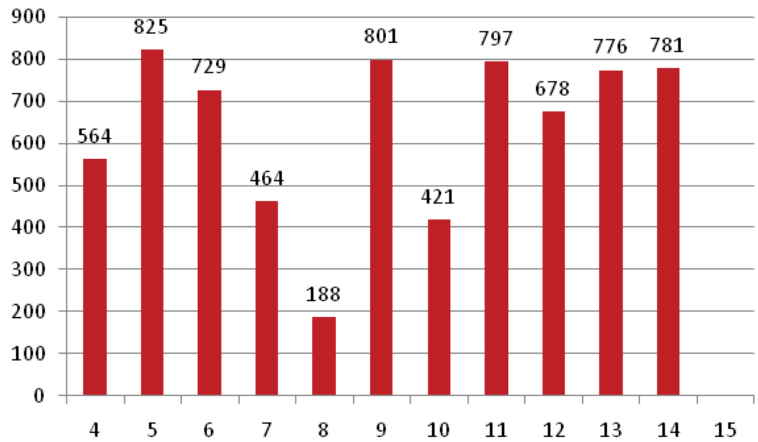
Graph 5.3.33 Team 8, Day 1



Graph 5.3.34 Team 8, Day 2

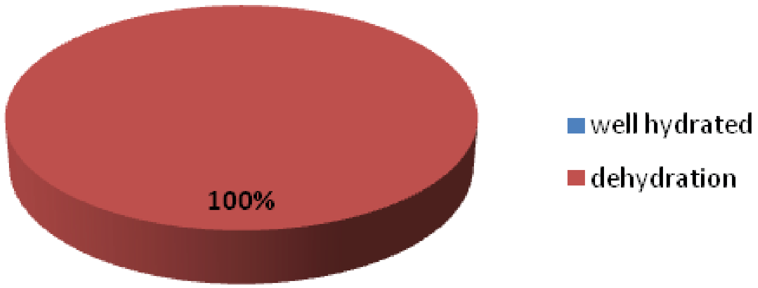


Graph 5.3.35 Team 8, Day 3

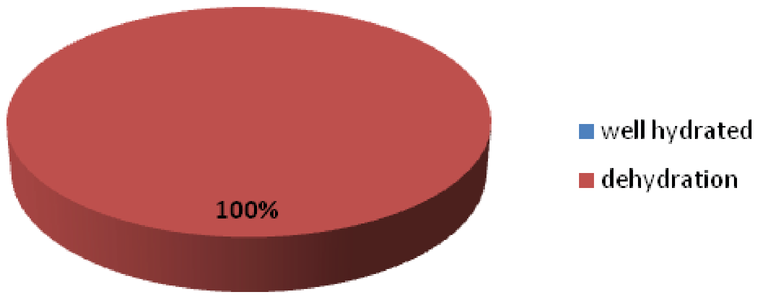


Graph 5.3.36 Team 8, After game

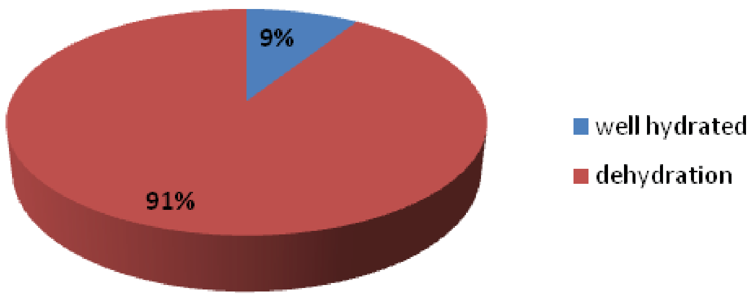
HYDRATATION STATUS -TEAM 1 (BY OSMOLALITY)



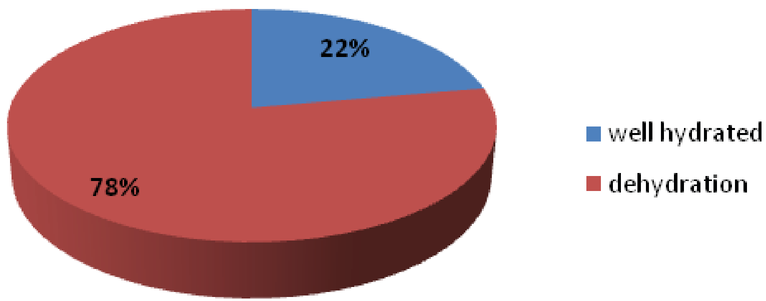
Graph 5.3.37 Morning urine, Day 1



Graph 5.3.38 Morning urine, Day 2

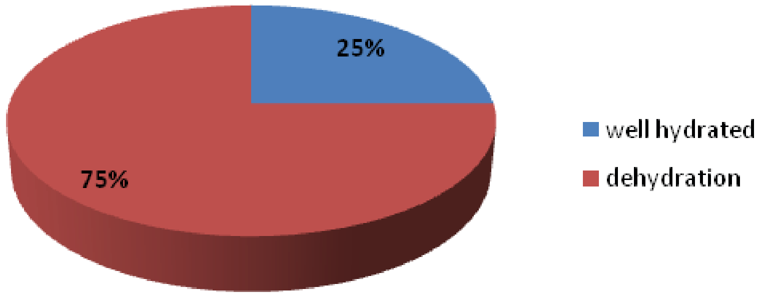


Graph 5.3.39 Morning urine, Day 3

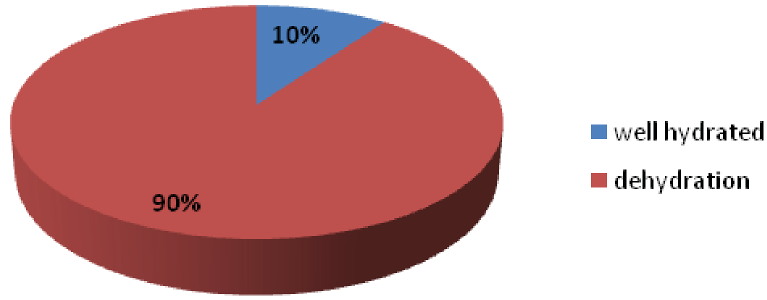


Graph 5.3.40 Urine after game

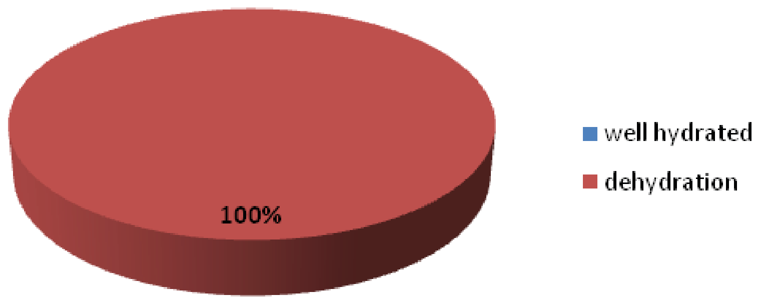
HYDRATATION STATUS -TEAM 2 (BY OSMOLALITY)



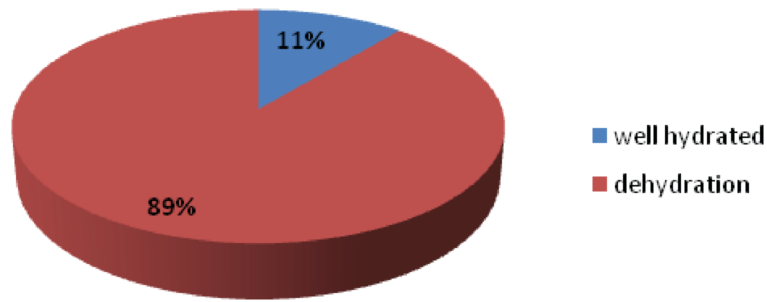
Graph 5.3.41 Morning urine, Day 1



Graph 5.3.42 Morning urine, Day 2

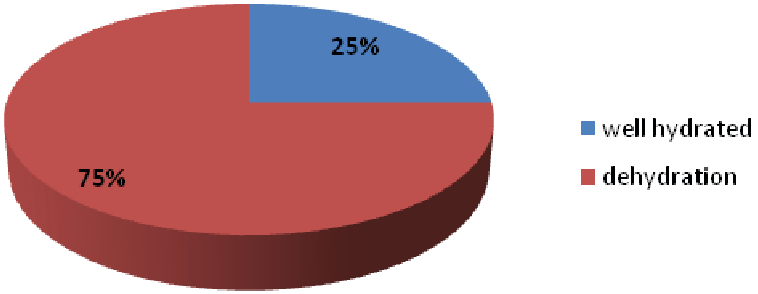


Graph 5.3.43 Morning urine, Day 3

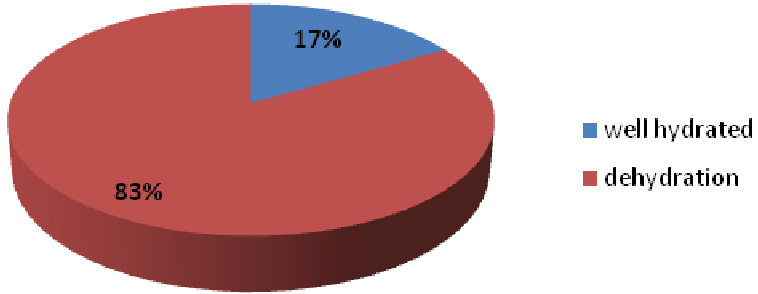


Graph 5.3.44 Urine after game

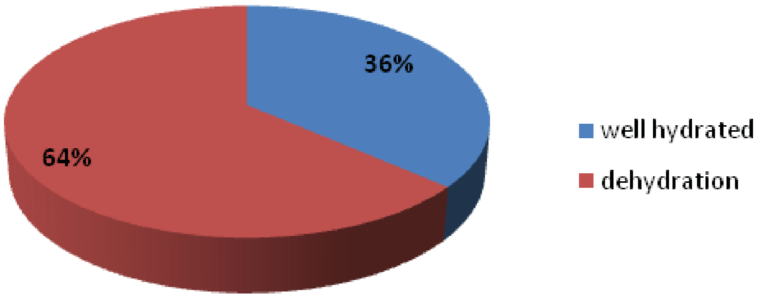
HYDRATATION STATUS -TEAM 3 (BY OSMOLALITY)



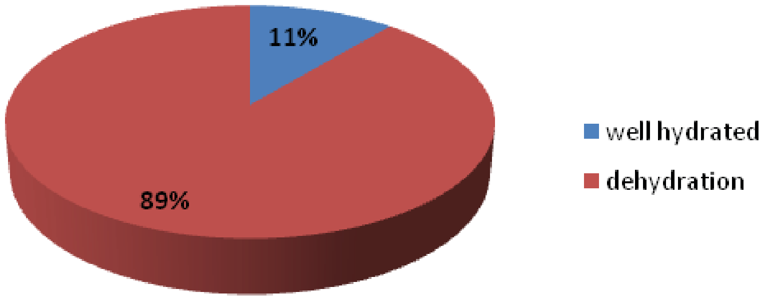
Graph 5.3.45 Morning urine, Day 1



Graph 5.3.46 Morning urine, Day 2

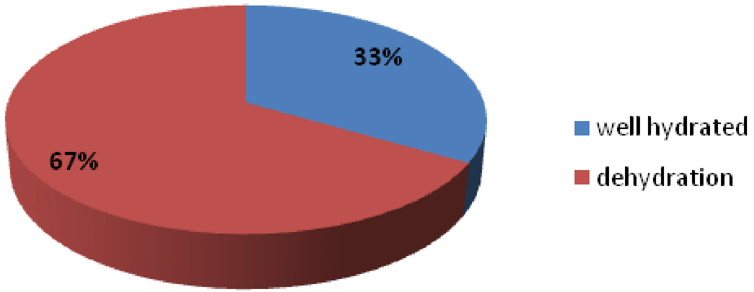


Graph 5.3.47 Morning urine, Day 3

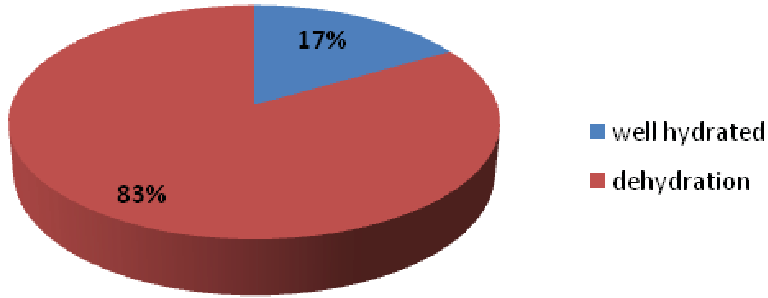


Graph 5.3.48 Urine after game

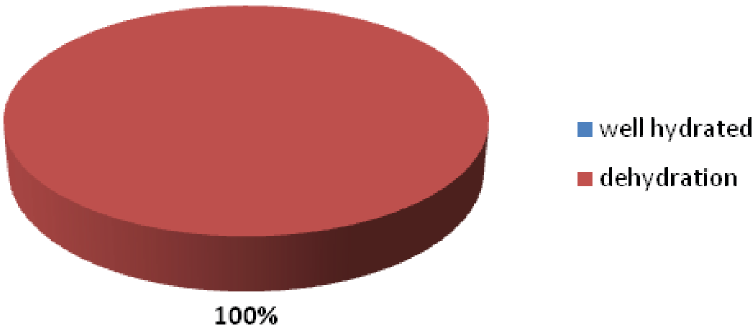
HYDRATATION STATUS -TEAM 4 (BY OSMOLALITY)



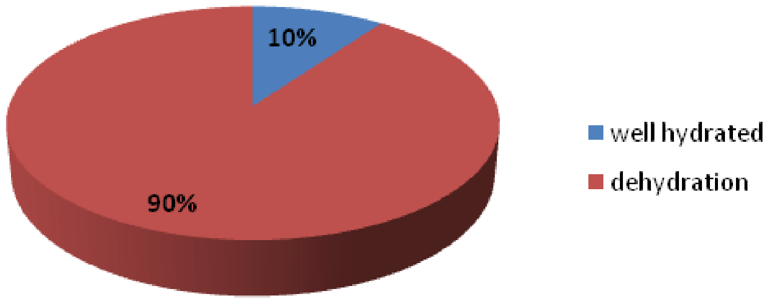
Graph 5.3.49 Morning urine, Day 1



Graph 5.3.50 Morning urine, Day 2

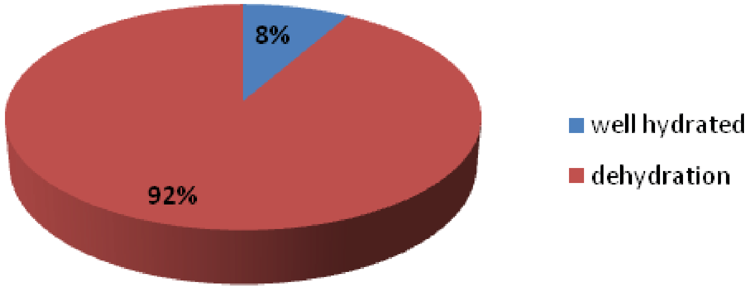


Graph 5.3.51 Morning urine, Day 3

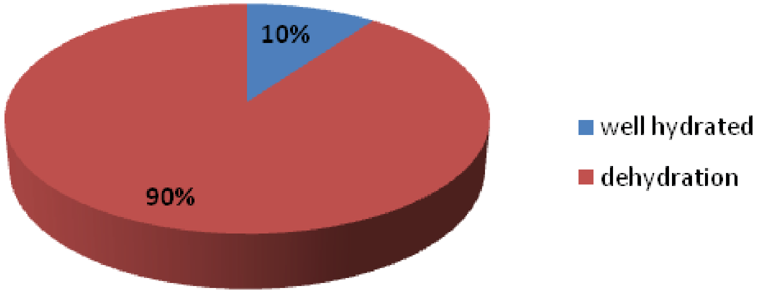


Graph 5.3.52 Urine after game

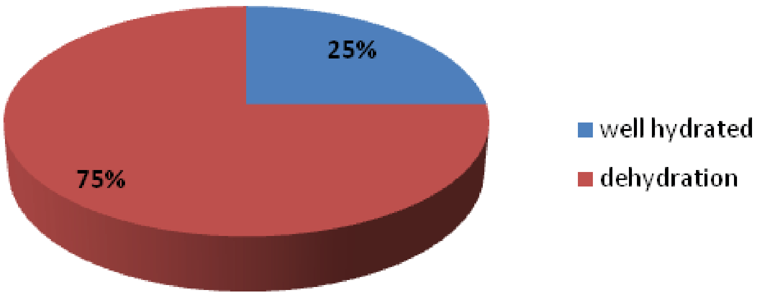
HYDRATATION STATUS -TEAM 5 (BY OSMOLALITY)



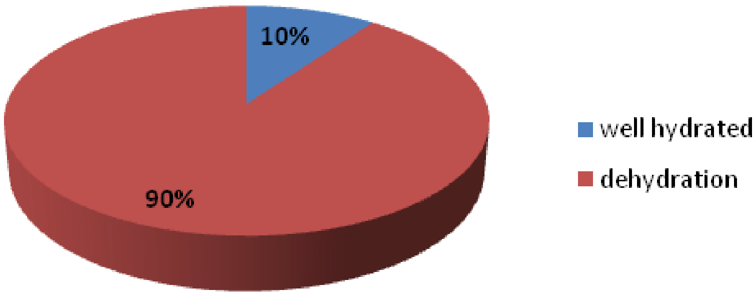
Graph 5.3.53 Morning urine, Day 1



Graph 5.3.54 Morning urine, Day 2

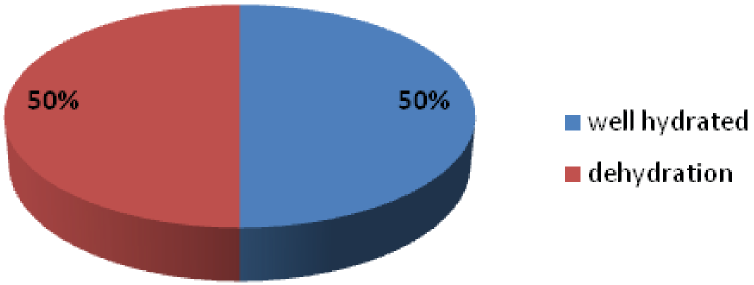


Graph 5.3.55 Morning urine, Day 3

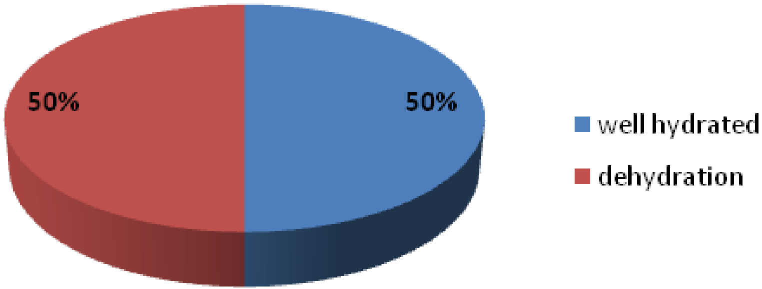


Graph 5.3.56 Urine after game

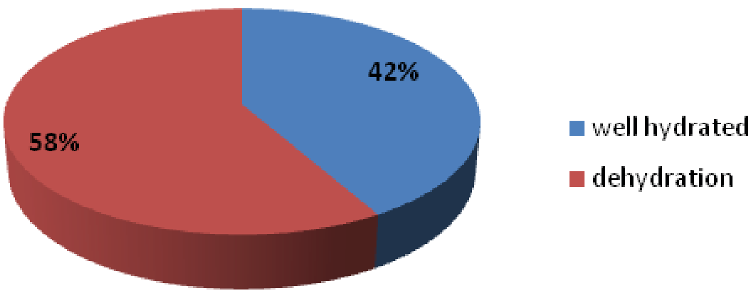
HYDRATATION STATUS -TEAM 6 (BY OSMOLALITY)



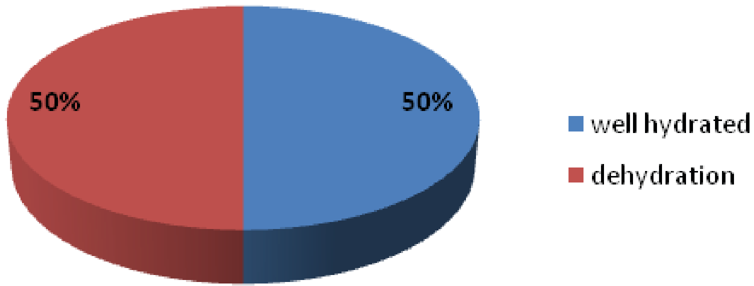
Graph 5.3.57 Morning urine, Day 1



Graph 5.3.58 Morning urine, Day 2

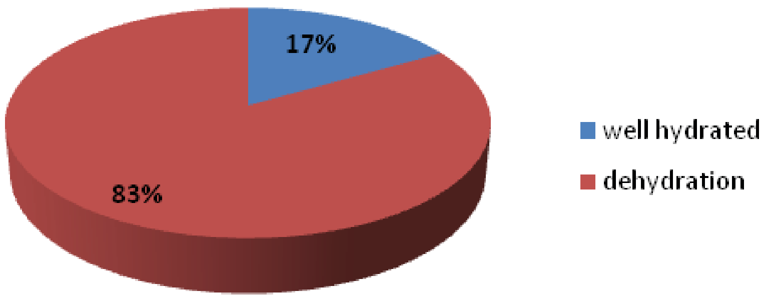


Graph 5.3.59 Morning urine, Day 3

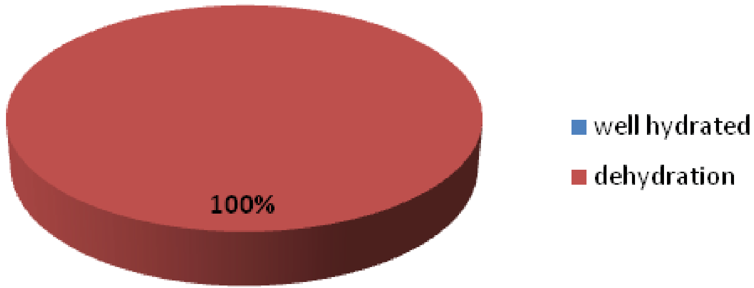


Graph 5.3.60 Urine after game

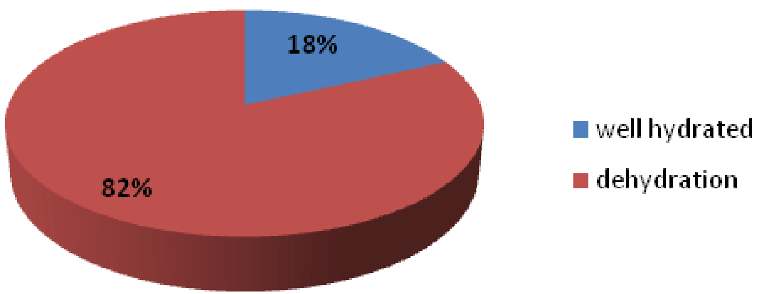
HYDRATATION STATUS -TEAM 7 (BY OSMOLALITY)



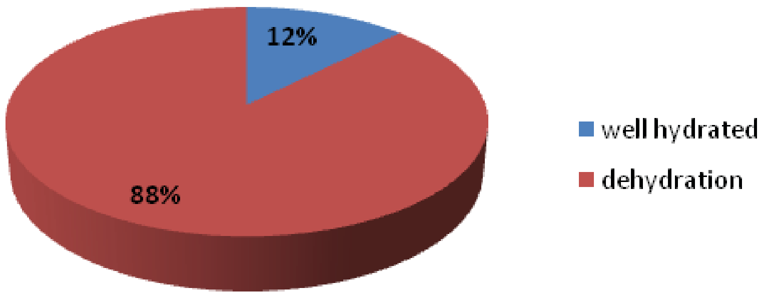
Graph 5.3.61 Morning urine, Day 1



Graph 5.3.62 Morning urine, Day 2

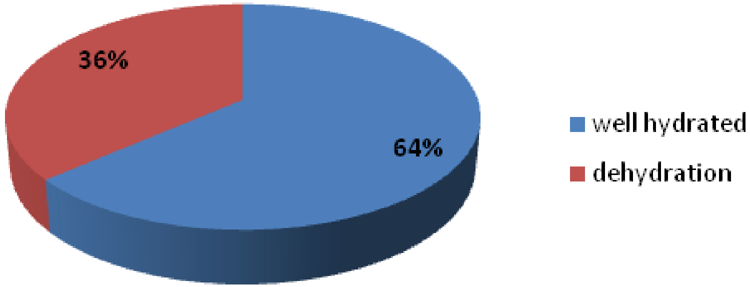


Graph 5.3.63 Morning urine, Day 3

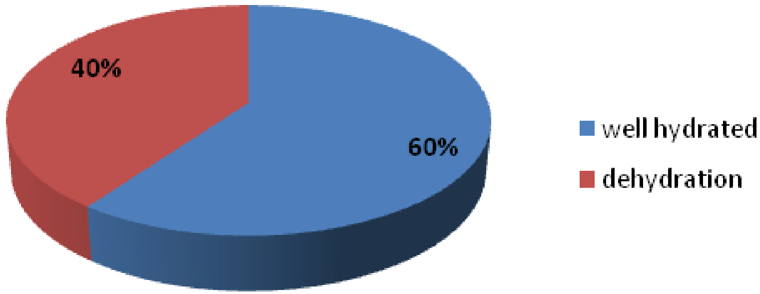


Graph 5.3.64 Urine after game

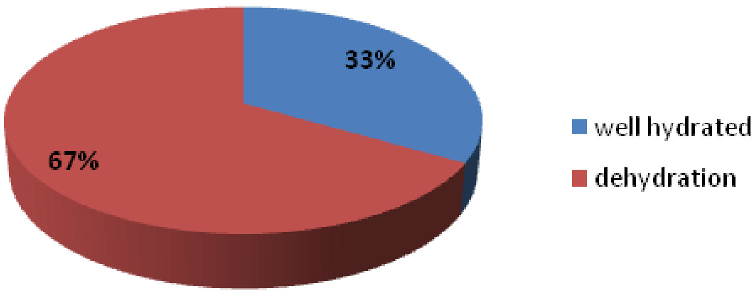
HYDRATATION STATUS -TEAM 8 (BY OSMOLALITY)



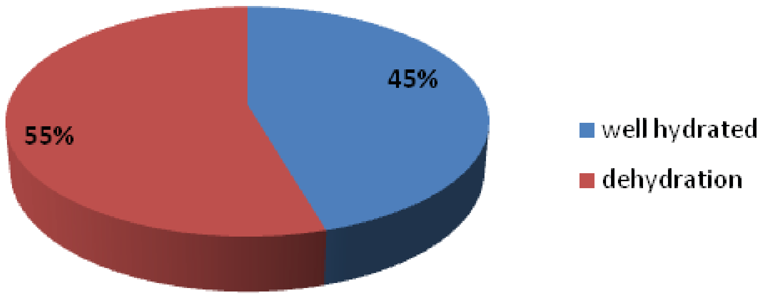
Graph 5.3.65 Morning urine, Day 1



Graph 5.3.66 Morning urine, Day 2



Graph 5.3.67 Morning urine, Day 3



Graph 5.3.68 Urine after game

6. DISSCUSION

Study performed during U20 European Championship Men 2011-Division B in Sarajevo clearly showed the importance for proper hydration during practise and competition.

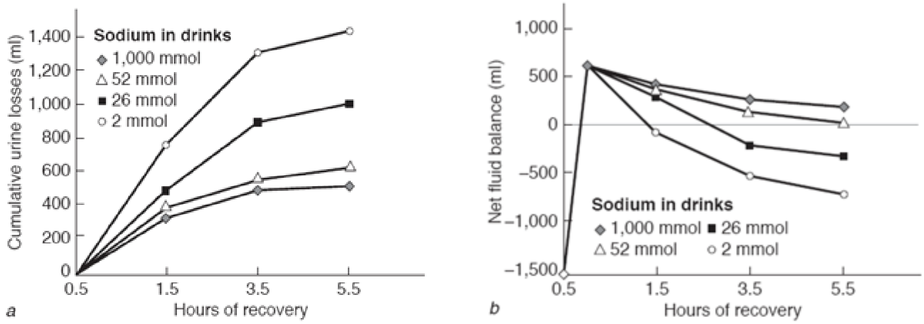
Using all 3, objective, parameters for acquiring hydration status (urine specific gravity, urine colour and urine osmolality) without any doubt we could say that teams failed to establish and maintain proper hydration.

6.1. FLUID INTAKE

Graph 4.1.1 shows that there is difference of more than 2 times between teams with highest and lowest average fluid intake during the game. Team 5 players took in average 2435 ml of fluid (37.4% more than overall average) comparing with Team 4 players who took 1191 ml of fluid in average (32.8% less than overall average). Average fluid intake per player for all teams is only 1772 ml.

There is difference between teams in composition of fluids, which they used for hydration. While some of them took water, some teams used sport drinks and some of them both.

The optimal sodium level in a rehydration drink appearsto be 50 to 80 mmol/L (Maughan and Leiper 1995), as is provided in oral rehydration solutions manufactured for the treatment of diarrhea. This is considerably higher than the concentrations found in commercial carbohydrate–electrolyte drinks, or sport drinks (typically 10-25 mmol/L), and may be unpalatable to many athletes. Sport drinks may confer some rehydration advantages over plain water, in terms of palatability as well as fluid retention (Gonzalez-Alonso et al. 1992). Nevertheless, where maximum fluid retention is desired, there may be benefits in increasing the sodium levels of rehydration fluids to levels above those provided in typical sport drinks (Maughan and Leiper 1995).

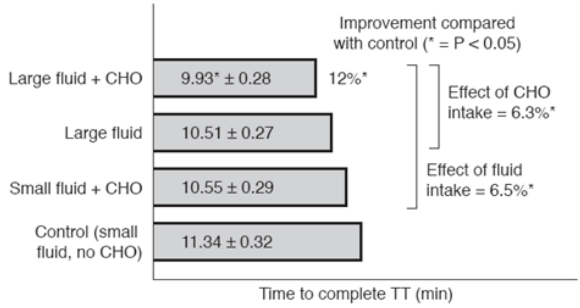


Graph 6.1.1

(a) Effect of sodium replacement on hydration. The presence of sodium in fluids consumed after exercise (replacing 150% of the fluid deficit) reduced urine losses and *(b)* enhanced net fluid balance at the end of 6 hr of recovery. The optimal level of sodium appears to be about 50 mmol/L, because a greater sodium concentration did not further enhance the effect. With little or no sodium replacement, participants were still dehydrated at the end of the 6 hr recovery period. Reprinted from Maughan and Leiper 1995.

Today, during exercise of greater than 60 to 90 min duration, athletes are encouraged to consume a source of carbohydrate to provide an available glucose supply of at least 30 to 60 g/hr (Coyle 2004). A range of carbohydrate of moderate and high glycemic index appears to provide a suitable fuel supply, reaching a maximal rate of oxidation of ~1 g/min after ~60 min of exercise, at least in the case of single carbohydrate sources (for review, see Jeukendrup and Jentjens 2000). Recent studies feeding multiple sources of carbohydrate in the same drink have reported maximal oxidation rates of 1 to 1.3 g/min with the consumption of very large carbohydrate amounts (Jentjens, Achten, et al. 2004; Jentjens, Moseley, et al. 2004).

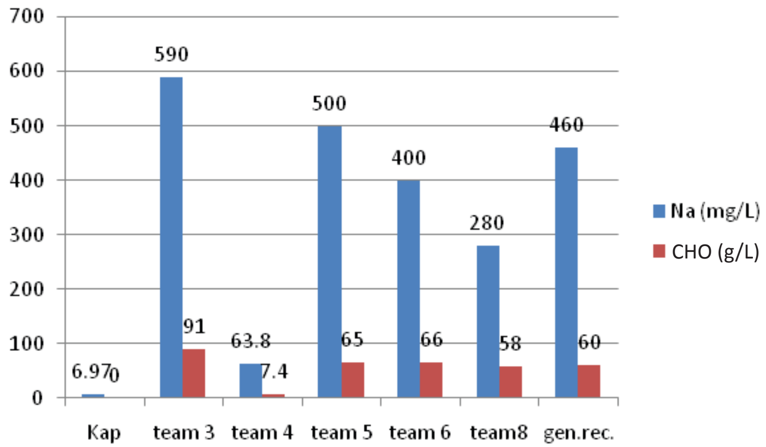
Sport drinks provide a convenient form of carbohydrate intake during exercise for most athletes. However, the culture and conditions of many sports allow a range of carbohydrate-containing foods and drinks to be consumed to meet fuel needs during the event.



Graph 6.1.2

Well-trained cyclists undertook four trials in random order of cycling at 80% VO2max followed by a time trial. Treatments involved replacement of either fluid, carbohydrate (CHO), or both fluid and carbohydrate, compared with a trial in which placebo capsules were consumed. Results show that fluid and carbohydrate replacement independently enhanced time trial performance and that the effects of these strategies were additive. (Data drawn from Below et al. 1995.)

If we analyze content of fluid taken by the team on U20 Championship in comparison with generally recommended (Na 20 mmol/L and carbohydrates 60 g/L) it is obvious that water provided by organizer is not suitable for rehydration of basketball players and that intervention of five teams among eight who are controlled is justified.



Graph 6.1.3 Comparison of sports drinks used by teams with generaly recomended sports drinks (20mmol/l sodium (Na) and 60 g/l carbohydrates (CHO))

Team	Total Fluid Intake	Water	Isotonic Drink	Hydration Rank (by USG)	USG	Rank Sweat Rate	Sweat Rate	Temperature (C)
Team 5	2435 ml	1662 ml	773 ml	6	1028	2	3,15	31,1
Team 6	2109 ml	1182 ml	927 ml	1	1018	4	2,84	32,1
Team 7	2065 ml	2065 ml	0 ml	7	1028	1	3,40	31,2
Team 8	1961 ml	851 ml	1110 ml	2	1021	3	2,99	32,1
Team 1	1552 ml	1552 ml	0 ml	3	1025	6	2,45	27,8
Team 3	1519 ml	1153 ml	366 ml	5	1027	5	2,47	27,1
Team 2	1346 ml	1346 ml	0 ml	4	1026	7	1,79	27,4
Team 4	1191 ml	0 ml	1191 ml	8	1030	8	1,76	27,8

Table 6.1.4 Teams by average fluid intake, urine specific gravity and sweat rate

Best hydrated team is Team 6. Team 6 is ranked as number 2 for average fluid intake per player (mix of water and isotonic drink). Team 6 ranked as 4 for sweat rate and played game at temperature 32,1 C. Also, 43,15% of total fluid intake of Team 6 was portion of sport drink versus 31,75% for Team 5 which is reason for better hydration of Team 6.

Team 7 ranked as number 3 by average fluid intake but ranked as 7th by hydration status because they had highest sweat rate (3,40) and because they took only water.

Team 8 was ranked as 2nd by hydration status although ranked as 4th by fluid intake, but portion of sport drink in total fluid intake was 56.60%, more than Teams 6 and 5.

Teams 1, 2 and 3 although with smaller average fluid intake were ranked as 3, 4 and 5. Only Team 3 combined sport drink with water but portion of sport drink was smaller than with any other team, only 24,09%. All 3 teams had smaller average sweat rate than other teams and average temperature in which they played games was from 27,1 to 27,8 C (teams 5, 6, 7 and 8 played their games in temperature from 31,1 to 32,1 C).

Team 5 took in average more fluid than Team 6 (also mix of water and isotonic drink) but ranked as 6 by hydration because they rank as 2 by sweat rate (3,15) versus Team 6 which was ranked as 4 by sweat rate (2,84) and used less sport drink. Both teams played on very warm temperature (32,1 and 31,1 C) but yet they maintained good hydration status.

	% of sport drink used for rehydration
team 3	24,09%
team 4	100,00%
team 5	31,75%
team 6	43,15%
team 8	56,60%

Table 6.1.5 Percentage of sport drink used for rehydration

Team 7 ranked as number 3 by average fluid intake but ranked as 7th by hydration status because they had highest sweat rate (3,40) and because they took only water without any portion of sport drink.

Worst hydration status had Team 4. Average fluid intake was only 1191 ml per player (ranked as number 8 of 8 teams) but not in proper way. Namely, team 4 has used concentrated liquid for dissolving in water and they didn't follow instruction and they have dissolved only 10 ml instead of 100 ml in 1 liter of water. On that way they didn't improve hydration status of their athletes in spite they have used only that drink.

6.2. ENVIRONMENTAL CONDITIONS

Average temperature in sport halls where games had been played was in average 28,2 C (range from 26,4 - 32,5 C) and average humidity 54,8% (range 47%-60%)

6.3. SWEAT RATE

Average sweat rate by teams varied from 1,76 to 3,40 l/h, which is very high. Some previous studies showed that maximal sweat rate for male basketball players is 1,79 l/h. High temperature in sport halls where games were played is, for sure, important factor for such high values of sweat rate.

6.4. HYDRATION STATUS

For acquiring data on hydration status of each player we used three elements. All of them were taken in morning for 3 consecutive days and this data shows if players were adequate hydrated and took enough fluid on previous day.

Hydration status was also determined after game and this data shows if players were adequate hydrated during game.

Hydration status by specific gravity shows that best hydrated team in all 3 days and after game had average urine specific gravity of 1017 (minimal dehydration). Most of teams had average urine specific gravity between 1020 and 1030 that is equally to significant dehydration and one team even had average specific gravity 1030, which means that players were in serious dehydration. None of teams had well hydrated players in average. Only Team 6 had in 2 of 4 urine samples some players, not all, who was well hydrated, while Team 1 and Team 8 had some well hydrated players in 1 of 4 urine samples. Five out of eight teams did not have a single well hydrated player in any of 4 urine analysis.

Urine colour analysis shows that all teams but one had average which shows significant dehydration status of player and some of them status of serious dehydration. Only one team, in 2 of 4 urine colour analysis, had average values that indicate minimal dehydration of players.

Finally, urine osmolality data shows that, in average, only 2 of 8 national teams had well hydrated players. All other teams had dehydrated players in all performed urine analysis.

CONCLUSIONS

1. **Quantity of water given to the teams is not adequate. Having in mind sweat rate and hydration status of player minimum of 2.5 litres is needed.**

2. **Sports drink, preferable Isotonic, should be considered as the only fluids for hydration after training or competition. Electrolyte replacement promotes proper rehydration, as well as carbohydrates are important in maintaining sport performance and because of that they are necessary to be in fluids for hydration.**

3. **All games should be played in sports hall that are air conditioned.**

4. **Although teams didn`t get enough fluid to achieve proper hydration of the players, it seems that players do not use even this quantity of fluid. Comprehensive action plan which would involve training for trainers, team doctors and players is needed to emphasise importance of proper hydration.**

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