NUTRITIONAL REQUIREMENTS FOR EXERCISE IN THE HOT ENVIRONMENT

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Competition in the hot environment is not conducive for optimal sport performance as both dehydration and hyperthermia adversely affects physical performance In addition, the ability to train in the hot environmentt is also impaired if the nutritional needs are inadequate

Carbohydrate is the main fuel used by the muscle during hard training and competition and its requirement for exercise in the hot conditions is further increased due to the shift in substrate utilization towards carbohydrate oxidation Daily food intake should focus on replacing glycogen stores after exercise Competition diet strategies such as enhancing carbohydrate availability (carbohydrate loading) prior to endurance competition, pre-event carbohydrate intake, intake of sports drinks in events lasting longer than 45 minutes should be undertaken in hot conditions and practiced during training Carbohydrate ingestion may not enhance performance for all events undertaken in hot environment, however, there is no disadvantage of consuming sports beverages containing the appropriate carbohydrates and electrolytes during competition and training

During prolonged bout of exercise in the hot environment, an excess body fluid through sweat can be lost Fluid intake strategies should be undertaken and should be of a paramount concern to the athlete if the athlete has to perform more than one training or competition sessions in a single day Fluid strategies which include hydration well prior to the exercise bout, drink as much as is comfortable and practical during the exercise session and rehydrate aggressively afterwards in preparation for the subsequent exercise bouts are needed to ensure an adequate water intake to prevent chronic dehydration during competition in hot conditions as the body does not adapt to dehydration Rapid recovery of fluid losses after an exercise bout is assisted by the replacement of some of the electrolytes losses

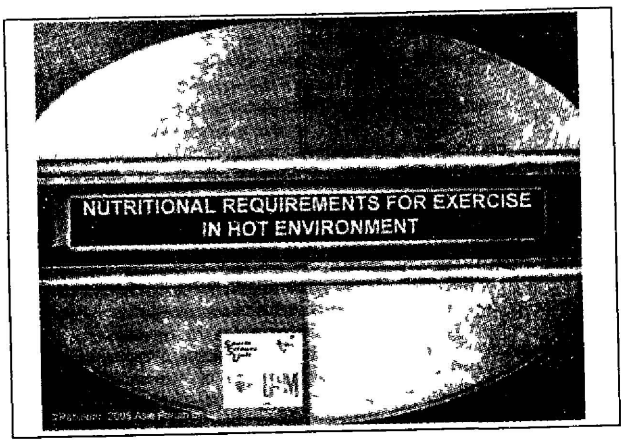
There is also no good evidence to suggest that specific supplementation is necessary or will improve performance in sport activities undertaken in hot environment

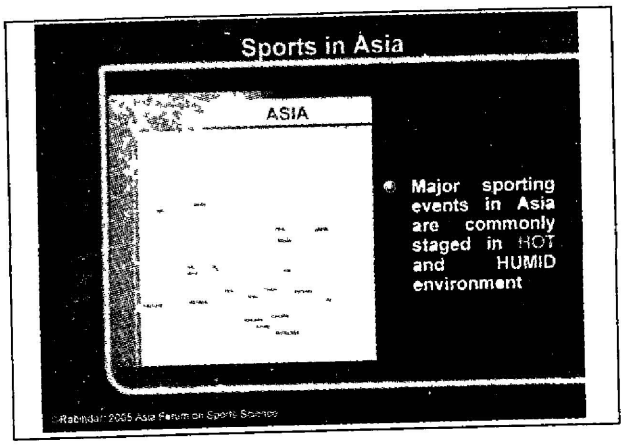
In conclusion, the primary aim of athletes training in the hot environment must ingest a source of energy, usually carbohydrate and fluids for replacement of water lost as sweat

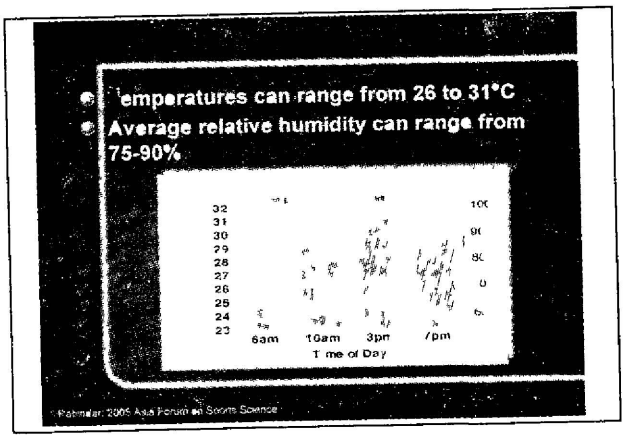
在热环境下运动的营养需要

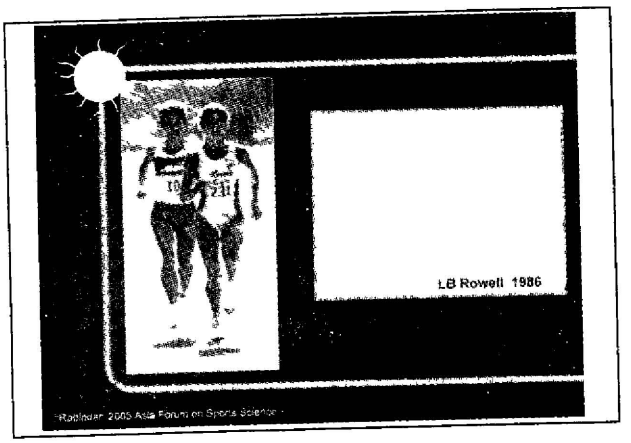
Rabindarjeet Singh 博士

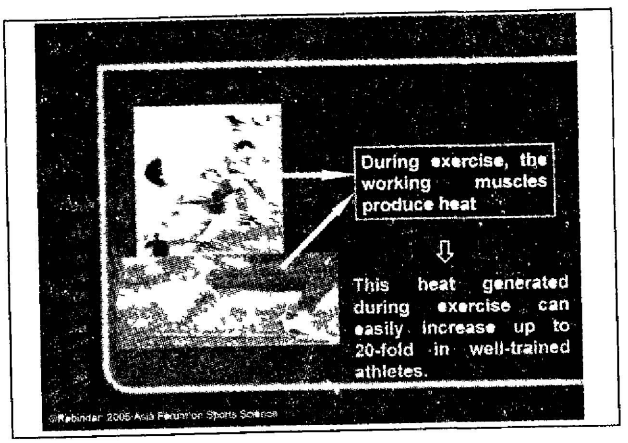
(马来西亚 Sains 大学 医学院 生理学教授)

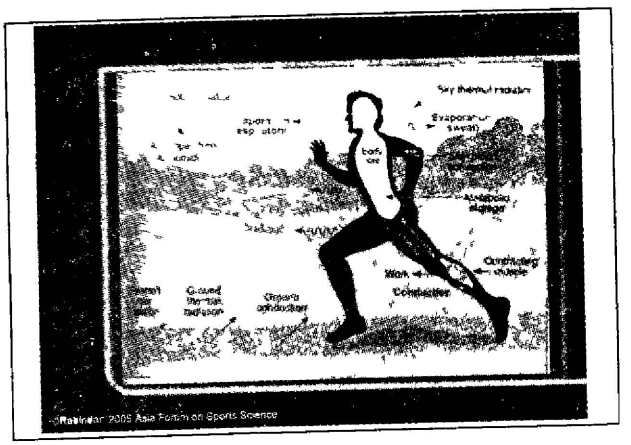


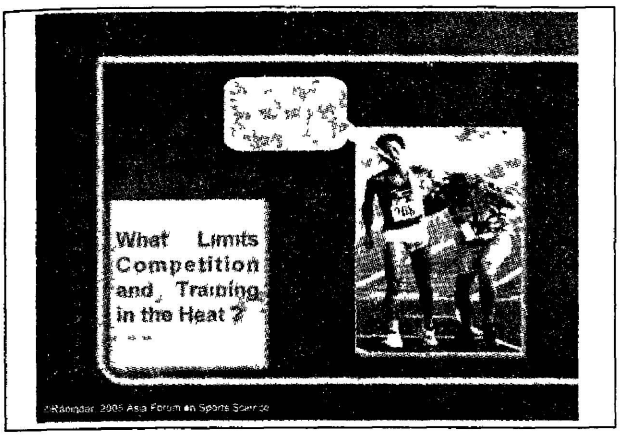


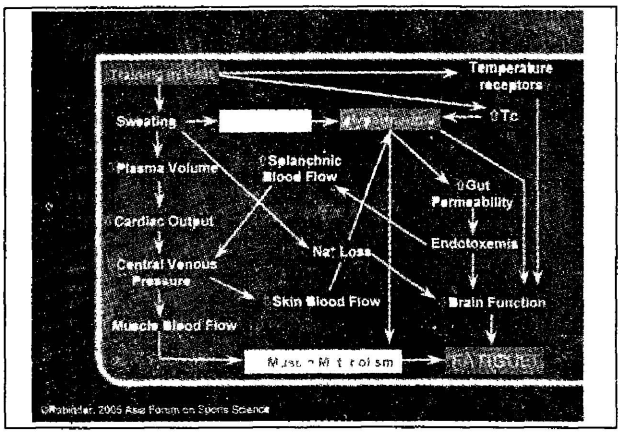


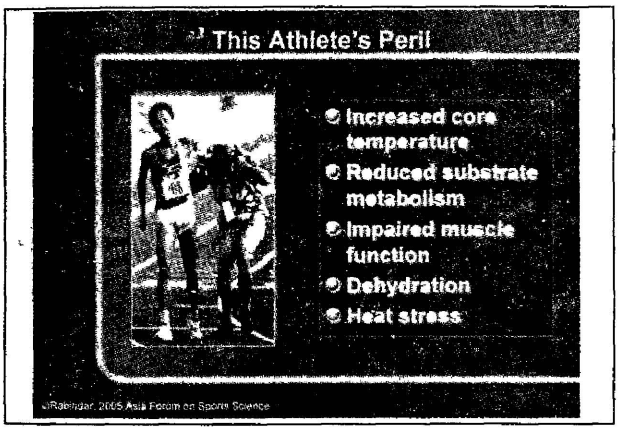


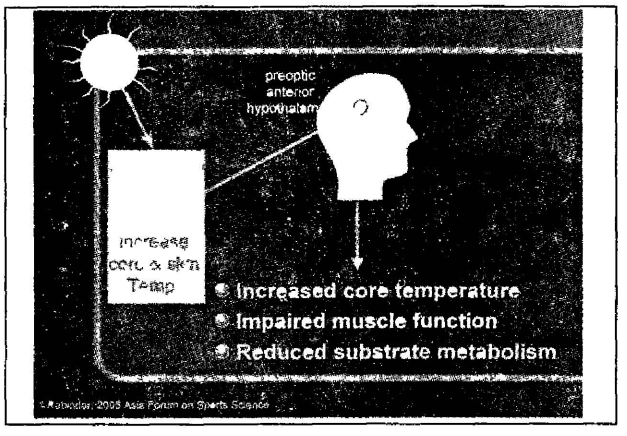


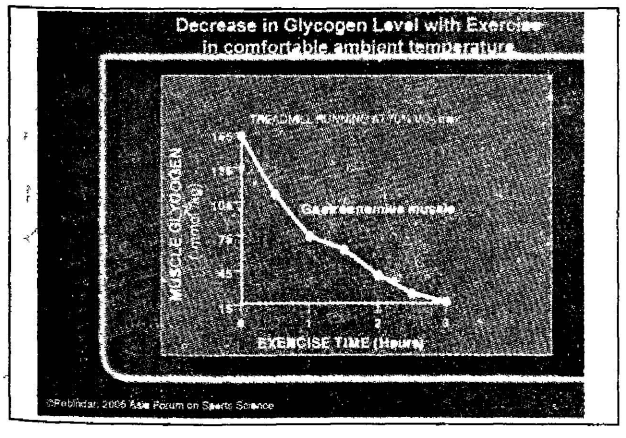


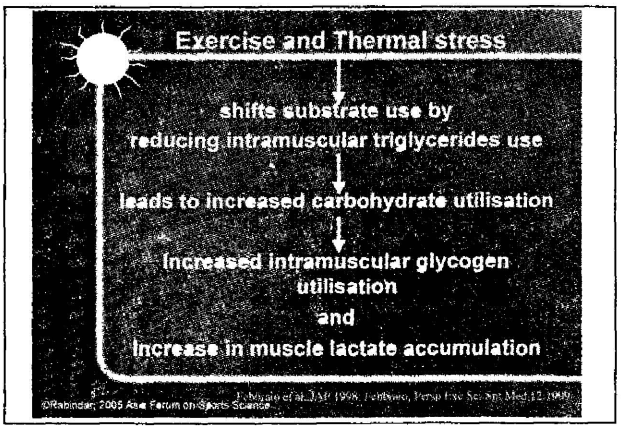

What Limits Competition and Training in the Heat?

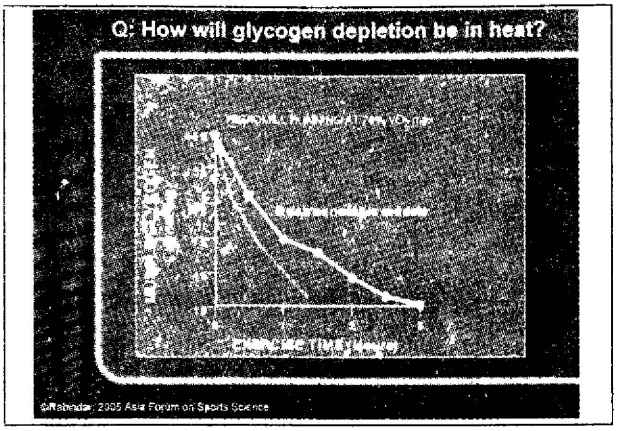

Temperature receptors
Sweating
⇧Tc
Plasma Volume
⇧Splanchnic Blood Flow
⇧Gut Permeability
Cardiac Output
Endotoxemia
Na+ Loss
Central Venous Pressure
Skin Blood Flow
Brain Function
Muscle Blood Flow
EXHAUSTION


This Athlete's Peril
Increased core temperature
Reduced substrate metabolism
Impaired muscle function
Dehydration
Heat stress


preoptic anterior hypothalamus
Increased core & skin Temp
Increased core temperature
Impaired muscle function
Reduced substrate metabolism


Decrease in Glycogen Level with Exercise in comfortable ambient temperature
MUSCLE GLYCOGEN
Gastrocnemius muscle
EXERCISE TIME (Hours)


Exercise and Thermal stress
shifts substrate use by reducing intramuscular triglycerides use
leads to increased carbohydrate utilisation
Increased intramuscular glycogen utilisation
and
Increase in muscle lactate accumulation


Q: How will glycogen depletion be in heat?
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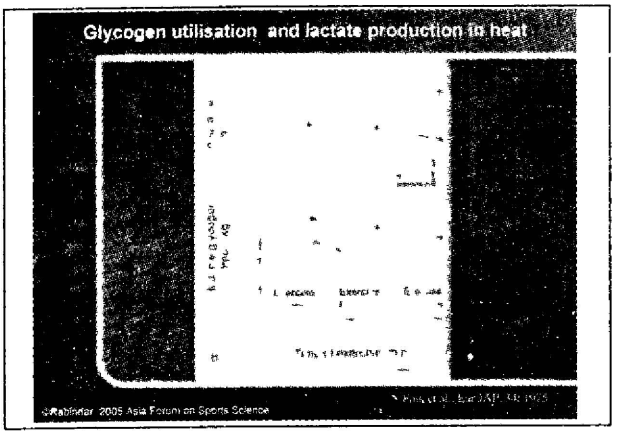
Glycogen utilisation and lactate production in heat
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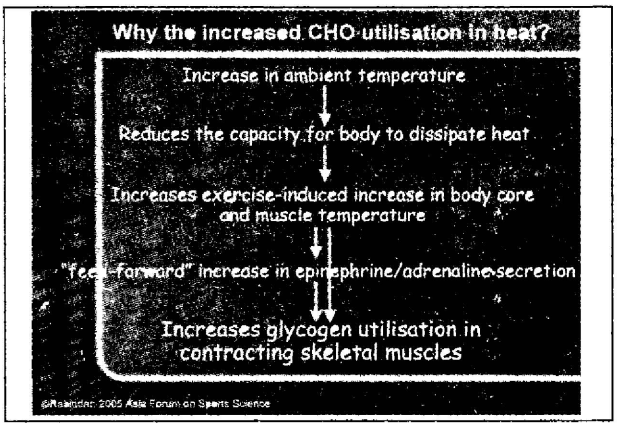
Why the increased CHO utilisation in heat?
Increase in ambient temperature
Reduces the capacity for body to dissipate heat
Increases exercise-induced increase in body core and muscle temperature
"feed-forward" increase in epinephrine/adrenaline secretion
Increases glycogen utilisation in contracting skeletal muscles
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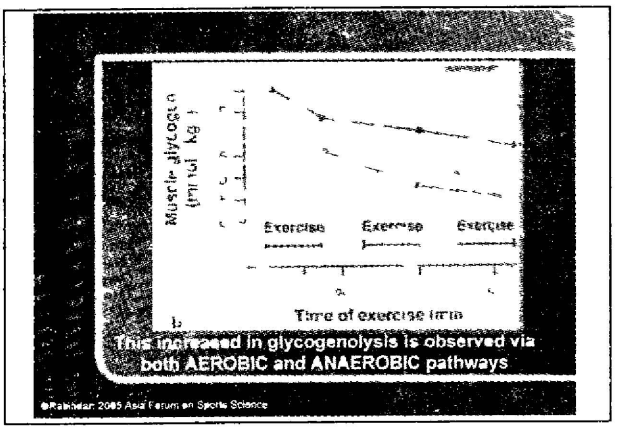
Exercise
Exercise
Exercise
Time of exercise (min)
This increased in glycogenolysis is observed via both AEROBIC and ANAEROBIC pathways
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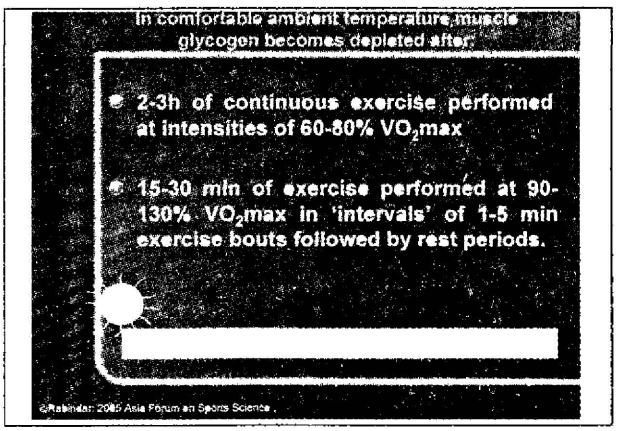
In comfortable ambient temperature muscle glycogen becomes depleted after:
2-3h of continuous exercise performed at intensities of 60-80% VO2max
15-30 min of exercise performed at 90-130% VO2max in 'intervals' of 1-5 min exercise bouts followed by rest periods.
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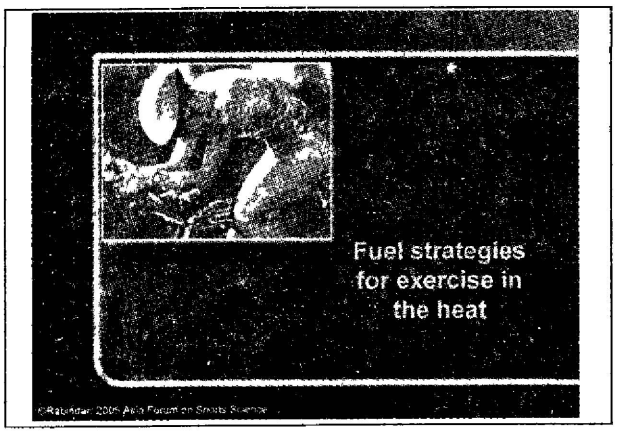
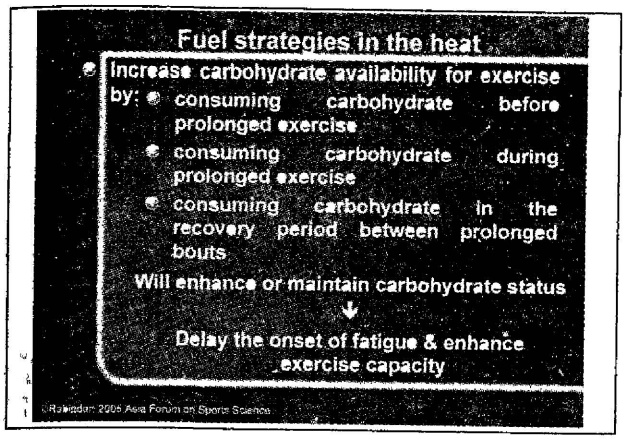

Fuel strategies for exercise in the heat


Fuel strategies in the heat
Increase carbohydrate availability for exercise by:
consuming carbohydrate before prolonged exercise
consuming carbohydrate during prolonged exercise
consuming carbohydrate in the recovery period between prolonged bouts
Will enhance or maintain carbohydrate status
Delay the onset of fatigue & enhance exercise capacity
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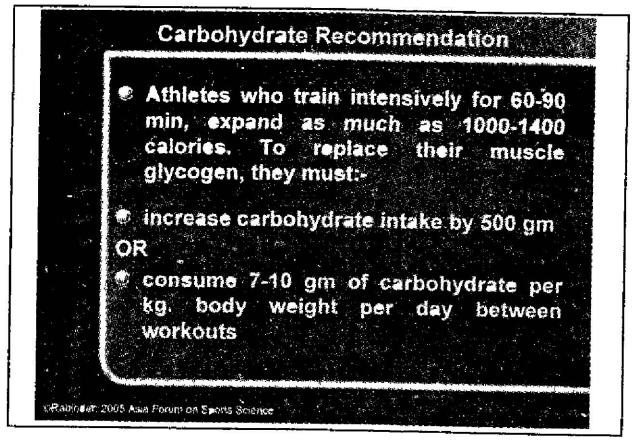
Carbohydrate Recommendation
Athletes who train intensively for 60-90 min, expand as much as 1000-1400 calories. To replace their muscle glycogen, they must:-
increase carbohydrate intake by 500 gm
OR
consume 7-10 gm of carbohydrate per kg. body weight per day between workouts
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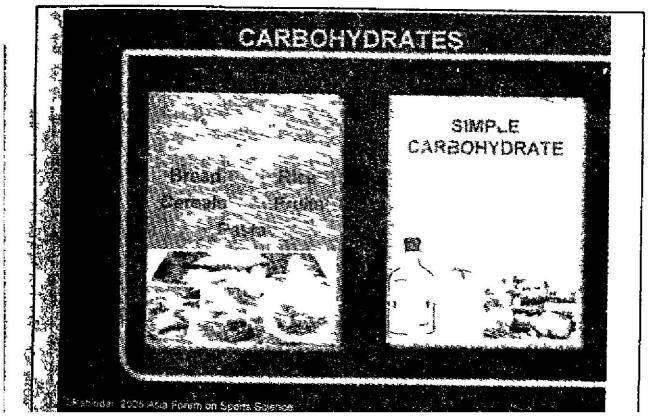
CARBOHYDRATES
SIMPLE CARBOHYDRATE
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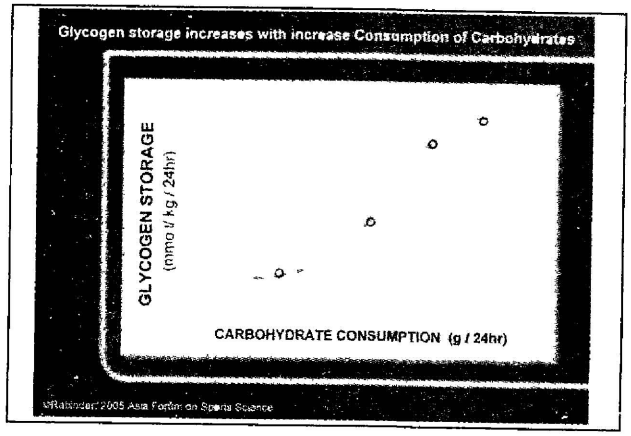
Glycogen storage increases with increase Consumption of Carbohydrates
GLYCOGEN STORAGE
(mmol / kg / 24hr)
CARBOHYDRATE CONSUMPTION (g / 24hr)
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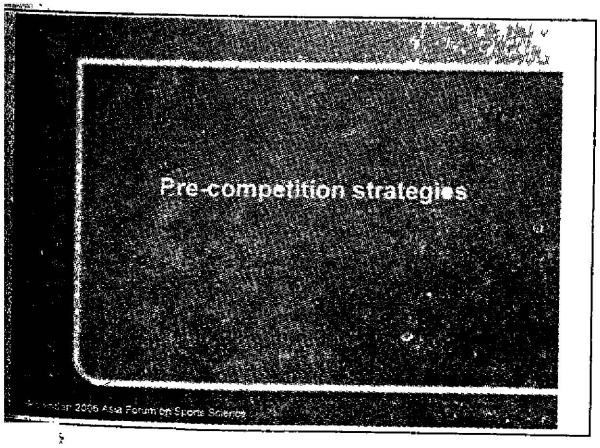
Pre-competition strategies
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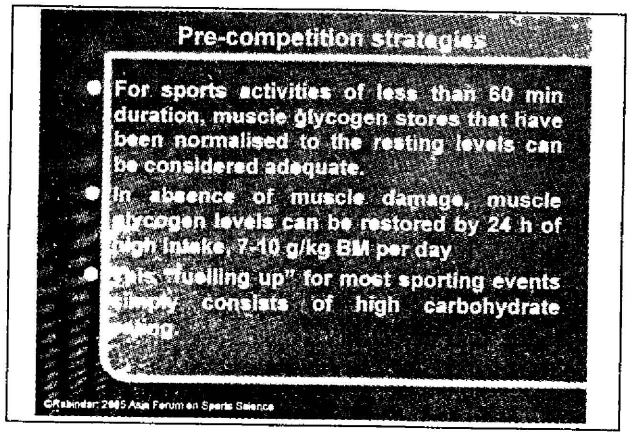
Pre-competition strategies
For sports activities of less than 60 min duration, muscle glycogen stores that have been normalised to the resting levels can be considered adequate.
In absence of muscle damage, muscle glycogen levels can be restored by 24 h of high intake, 7-10 g/kg BM per day
This "fuelling up" for most sporting events simply consists of high carbohydrate eating
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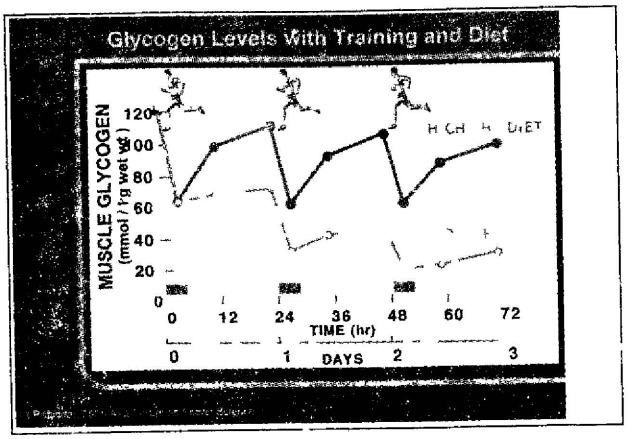
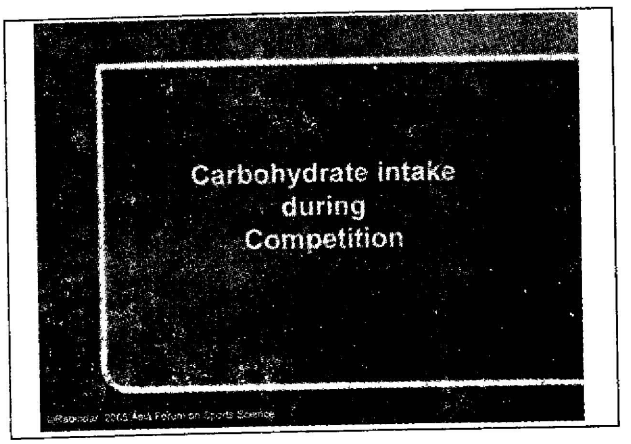
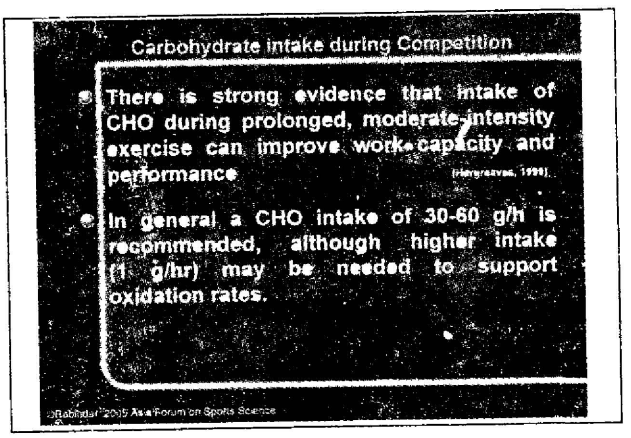
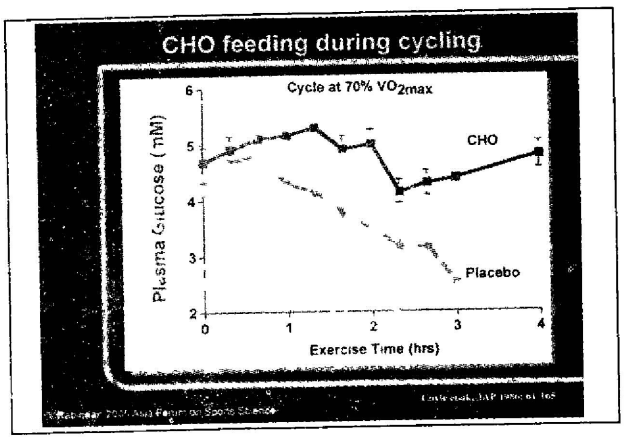
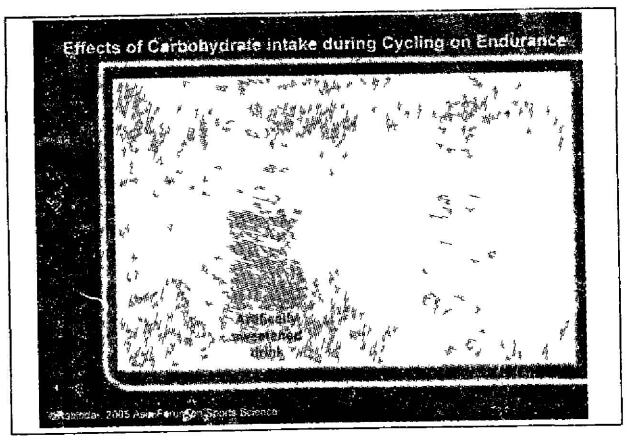
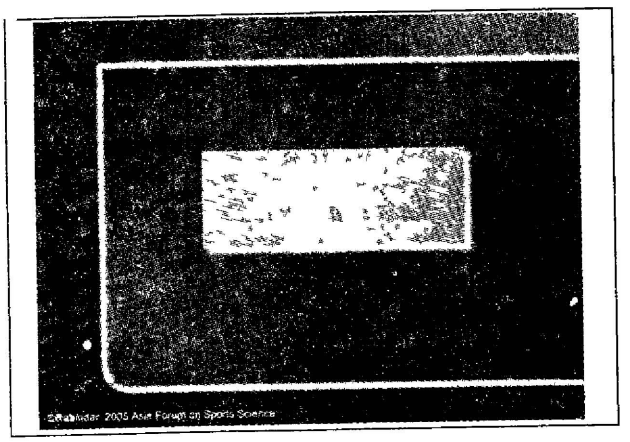

Glycogen Levels With Training and Diet
MUSCLE GLYCOGEN
(mmol / kg wet wt)
120
100
80
60
40
20
0
0
12
24
36
48
60
72
TIME (hr)
0
1
DAYS
2
3


Carbohydrate intake
during
Competition


Carbohydrate intake during Competition
There is strong evidence that intake of CHO during prolonged, moderate-intensity exercise can improve work capacity and performance
In general a CHO intake of 30-60 g/h is recommended, although higher intake (1 g/hr) may be needed to support oxidation rates.


CHO feeding during cycling
Cycle at 70% VO2max
Plasma Glucose (mM)
6
5
4
3
2
CHO
Placebo
0
1
2
3
4
Exercise Time (hrs)


Effects of Carbohydrate intake during Cycling on Endurance



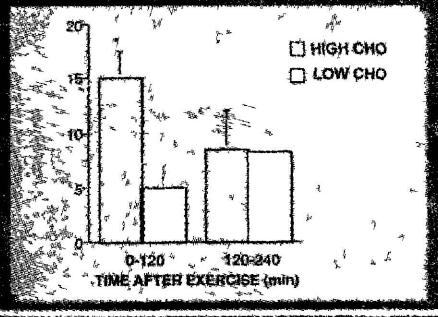
Post-exercise restoration of muscle glycogen

- Resynthesis of depleted glycogen stores is a key issue in post-exercise recovery and is a challenge for athletes who train or complete more than once a day.
- Moderate and high GI CHO-rich foods and drinks are more favourable for glycogen storage (Burke et al., 1993)

Recommendation for eating after competition

- Carbohydrate consumption after training ensures repletion of muscle glycogen.
- Research shows that muscle will replete glycogen stores to a higher level when up to 600g of easily digestible carbohydrate is consumed within the first two hours after training.
  - The main reason for promoting CHO-rich meals or snacks soon after exercise is that effective refuelling does not start until ~1g/kg BM CHO is consumed.

Glycogen resynthesis with high and low CHO



This Athlete's Peril

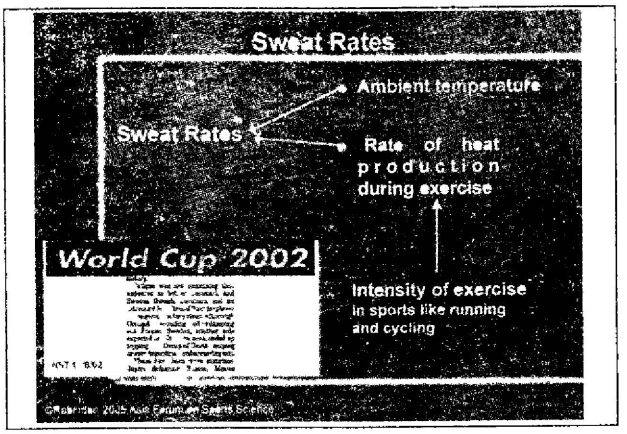
- Increased core temperature
- Reduced substrate metabolism
- Impaired muscle function
- Dehydration
- Heat stress

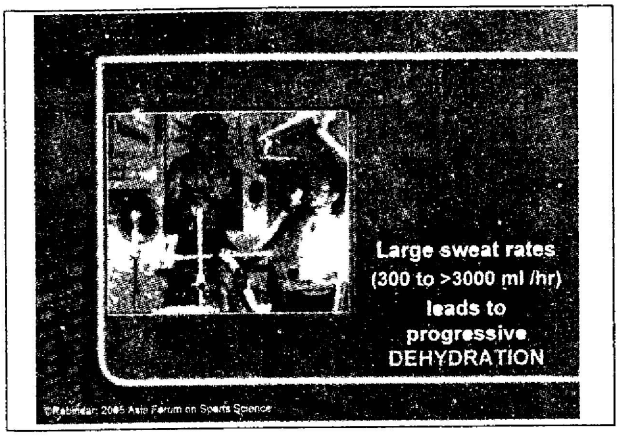
Fluid Strategies for Exercise in the heat

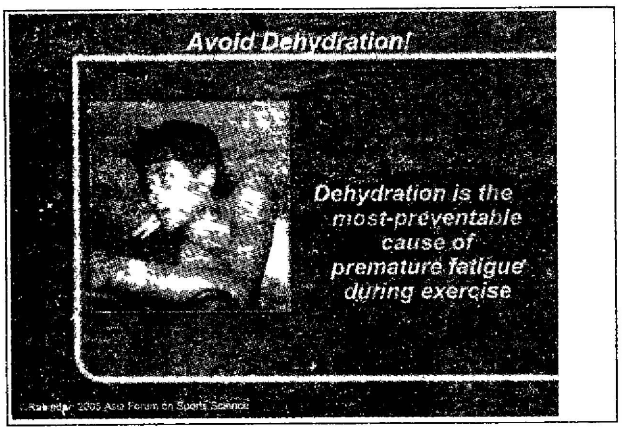
Thermal exchange during Exercise

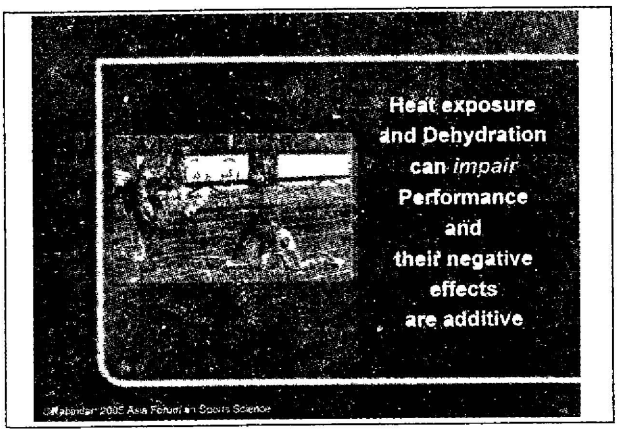
At rest, overheating is prevented through
- Radiation
- Convection
- Conduction
- Sweat evaporation

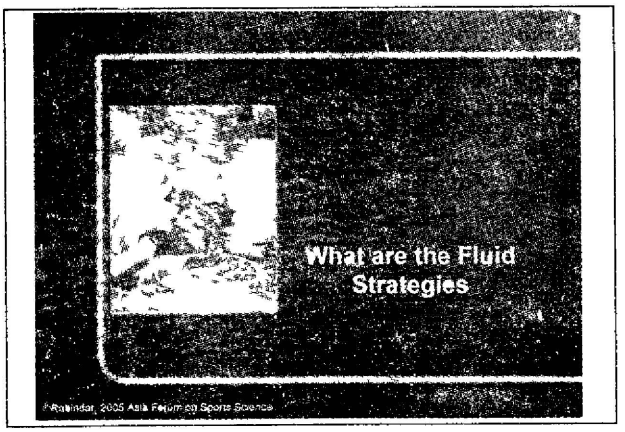
During exercise overheating is prevented through
- Radiation
- Convection
- Conduction
- Sweat evaporation

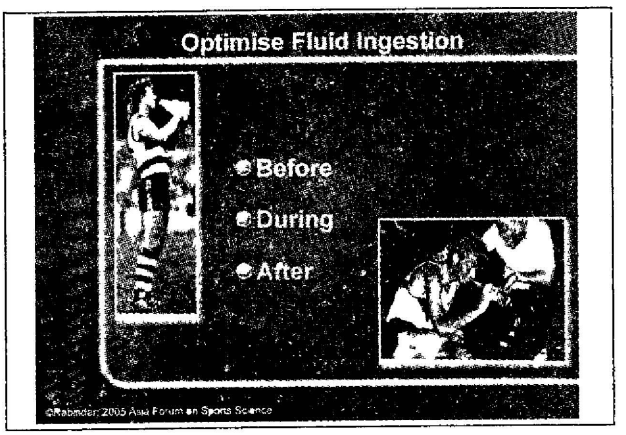

Sweat Rates
Ambient temperature
Sweat Rates
Rate of heat production during exercise
World Cup 2002
Intensity of exercise in sports like running and cycling

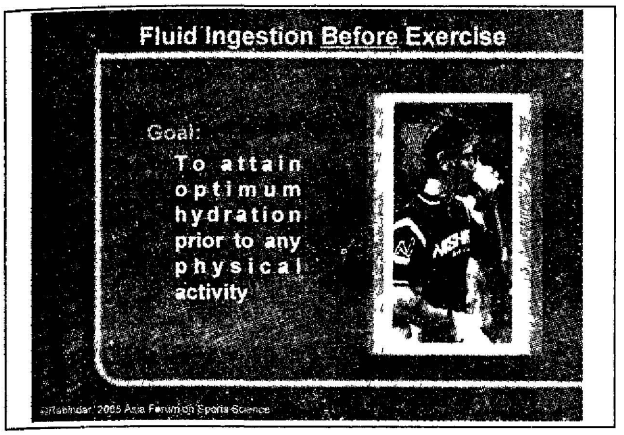

Large sweat rates (300 to >3000 ml /hr) leads to progressive DEHYDRATION

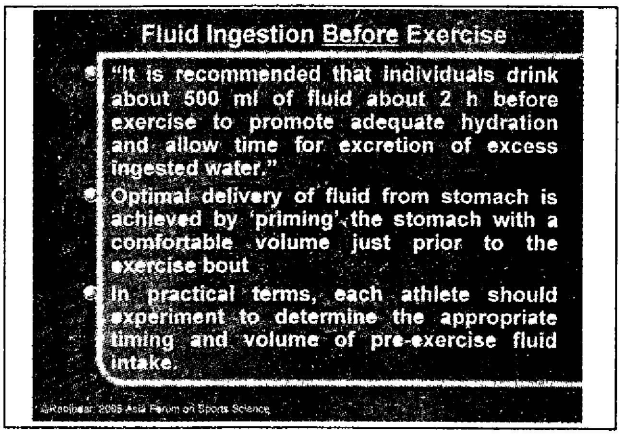

Avoid Dehydration!
Dehydration is the most-preventable cause of premature fatigue during exercise

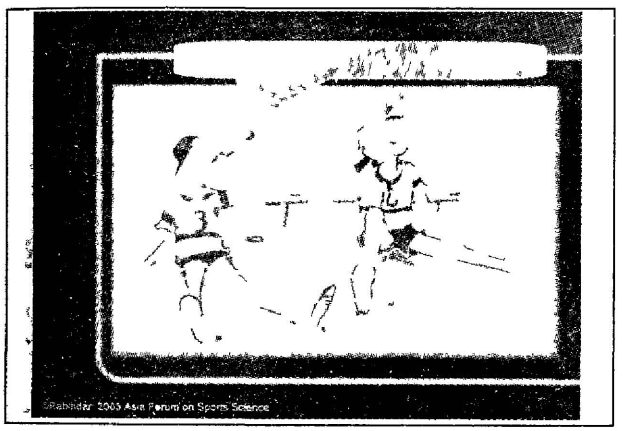

Heat exposure and Dehydration can impair Performance and their negative effects are additive

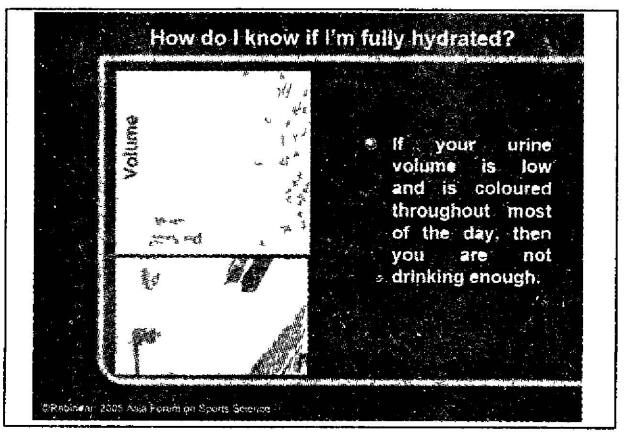

What are the Fluid Strategies

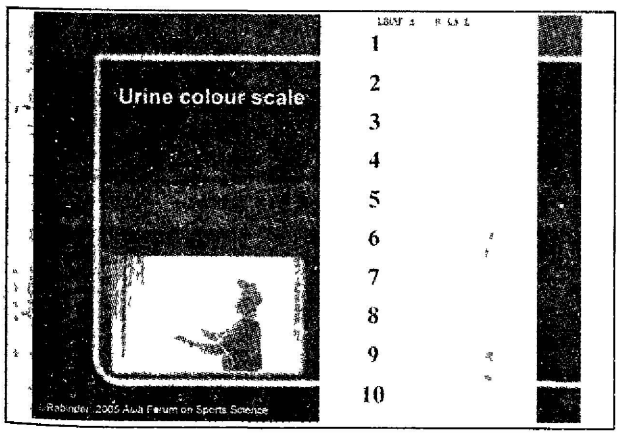

Optimise Fluid Ingestion
Before
During
After

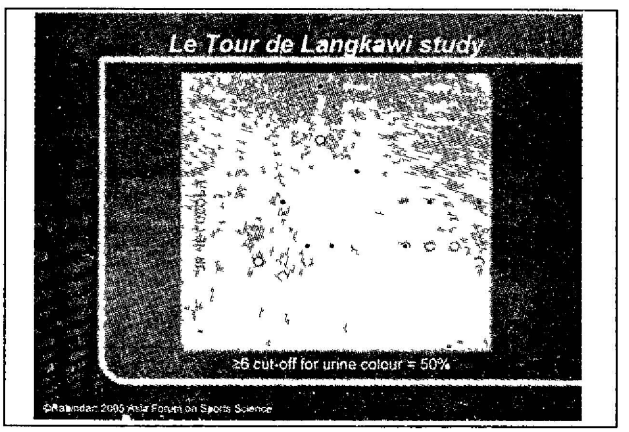

Fluid Ingestion Before Exercise
Goal:
To attain optimum hydration prior to any physical activity

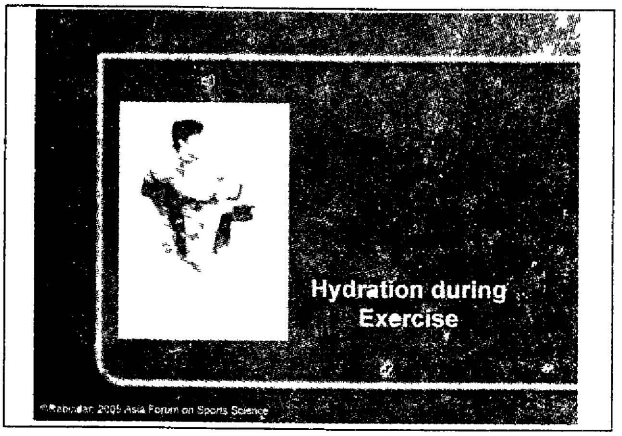

Fluid Ingestion Before Exercise
"It is recommended that individuals drink about 500 ml of fluid about 2 h before exercise to promote adequate hydration and allow time for excretion of excess ingested water."
Optimal delivery of fluid from stomach is achieved by 'priming' the stomach with a comfortable volume just prior to the exercise bout
In practical terms, each athlete should experiment to determine the appropriate timing and volume of pre-exercise fluid intake.




How do I know if I'm fully hydrated?
Volume
If your urine volume is low and is coloured throughout most of the day, then you are not drinking enough.


Urine colour scale
1
2
3
4
5
6
7
8
9
10


Le Tour de Langkawi study
≥6 cut-off for urine colour = 50%


Hydration during Exercise
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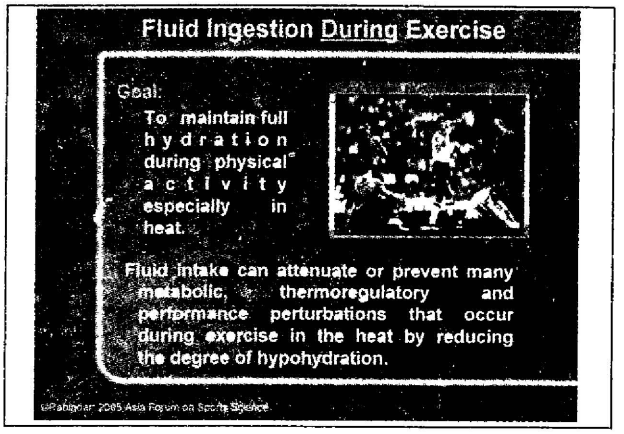
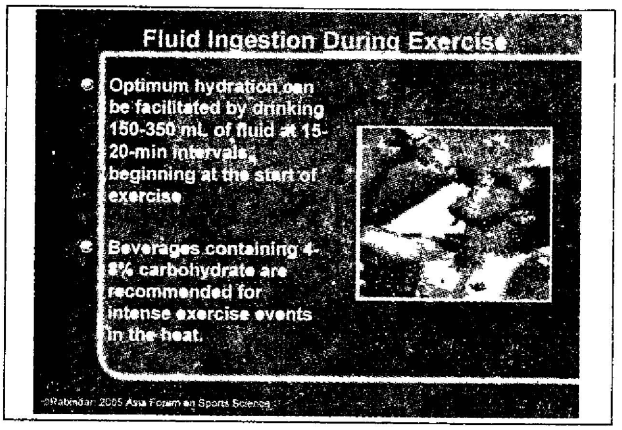
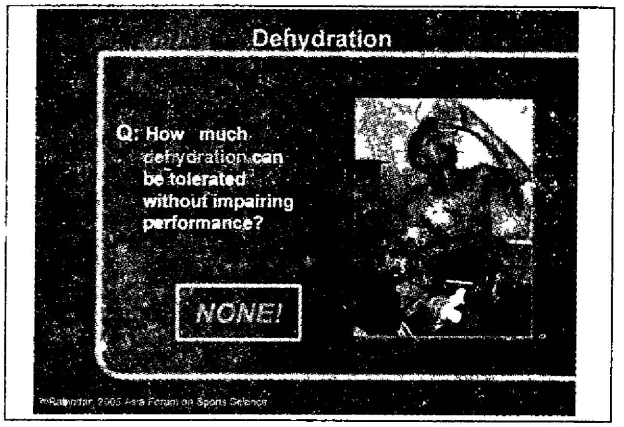
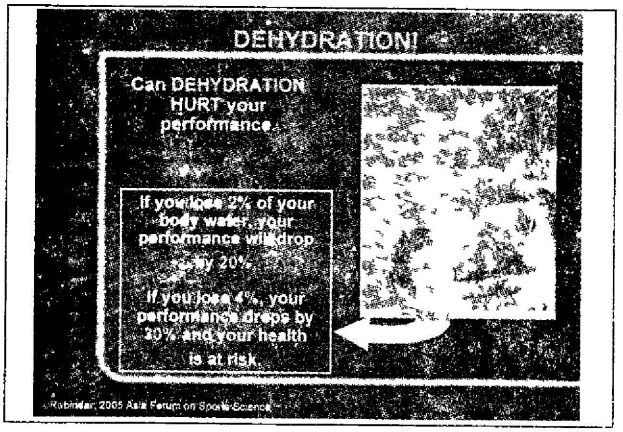
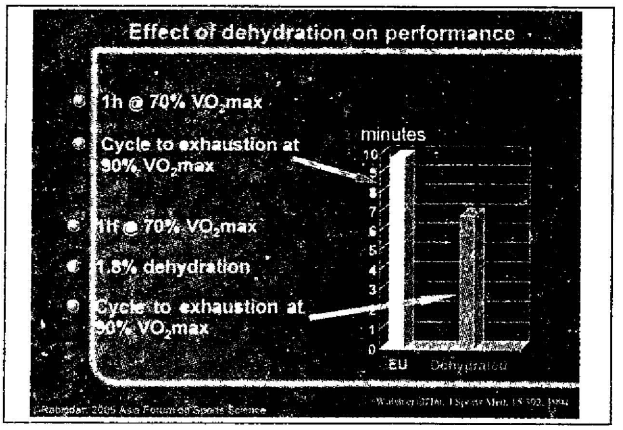
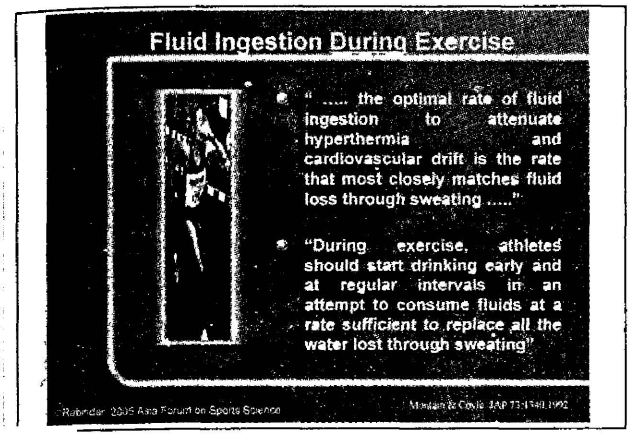

Fluid Ingestion During Exercise
Goal:
To maintain full hydration during physical activity especially in heat.
Fluid intake can attenuate or prevent many metabolic, thermoregulatory and performance perturbations that occur during exercise in the heat by reducing the degree of hypohydration.
Rabindar, 2005 Asia Forum on Sports Science

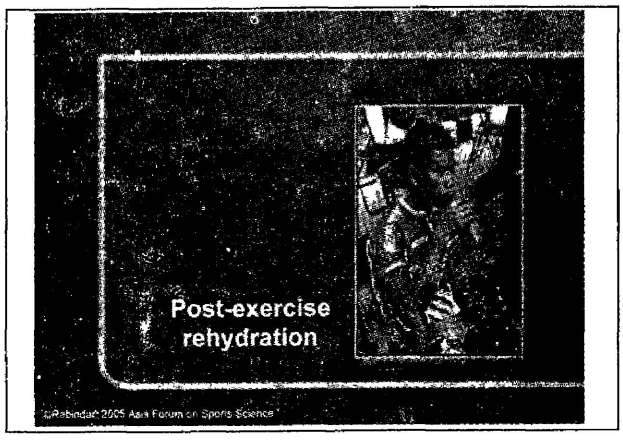

Fluid Ingestion During Exercise
Optimum hydration can be facilitated by drinking 150-350 mL of fluid at 15-20-min intervals, beginning at the start of exercise
Beverages containing 4-8% carbohydrate are recommended for intense exercise events in the heat.
Rabindar, 2005 Asia Forum on Sports Science


Dehydration
Q: How much dehydration can be tolerated without impairing performance?
NONE!
Rabindar, 2005 Asia Forum on Sports Science


DEHYDRATION!
Can DEHYDRATION HURT your performance...
If you lose 2% of your body water, your performance will drop by 20%
If you lose 4%, your performance drops by 30% and your health is at risk
Rabindar, 2005 Asia Forum on Sports Science


Effect of dehydration on performance
1h @ 70% VO2max
Cycle to exhaustion at 90% VO2max
minutes
10
9
8
7
6
5
4
3
2
1
0
1ff @ 70% VO2max
1.8% dehydration
Cycle to exhaustion at 90% VO2max
EU
Dehydrated
Rabindar, 2005 Asia Forum on Sports Science


Fluid Ingestion During Exercise
" ..... the optimal rate of fluid ingestion to attenuate hyperthermia and cardiovascular drift is the rate that most closely matches fluid loss through sweating ....."
"During exercise, athletes should start drinking early and at regular intervals in an attempt to consume fluids at a rate sufficient to replace all the water lost through sweating"
Rabindar 2005 Asia Forum on Sports Science
Montain & Coyle JAP 73:1340 1992


Post-exercise rehydration
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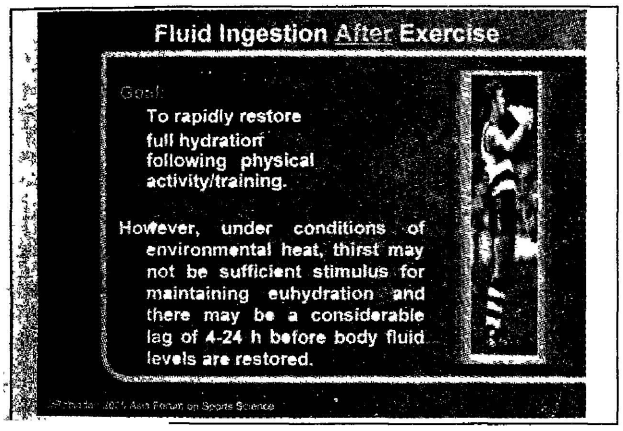
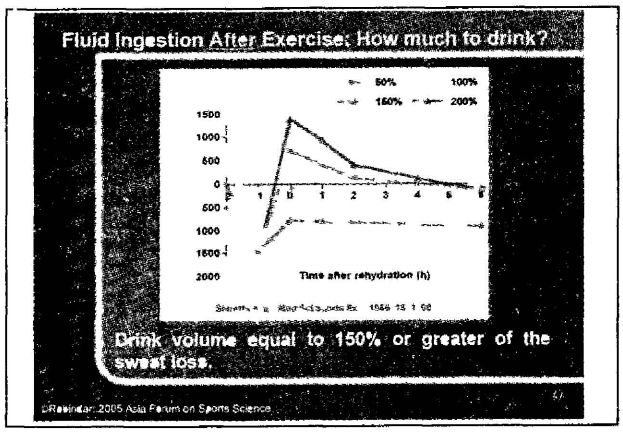

Fluid Ingestion After Exercise
Goal:
To rapidly restore full hydration following physical activity/training.
However, under conditions of environmental heat, thirst may not be sufficient stimulus for maintaining euhydration and there may be a considerable lag of 4-24 h before body fluid levels are restored.


Fluid Ingestion After Exercise: How much to drink?
50%
100%
150%
200%
1500
1000
500
0
500
1000
1500
2000
Time after rehydration (h)
Drink volume equal to 150% or greater of the sweat loss.
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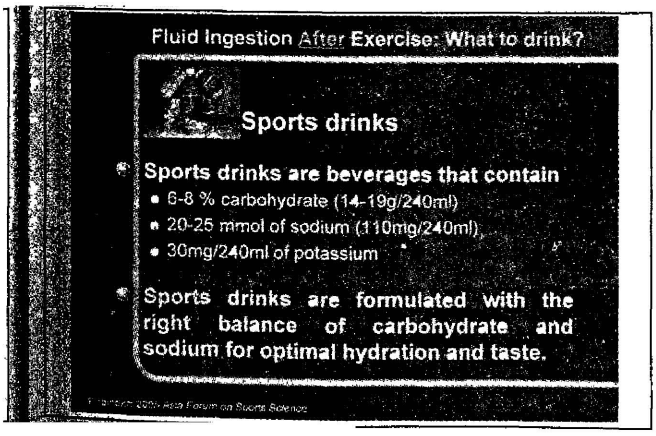
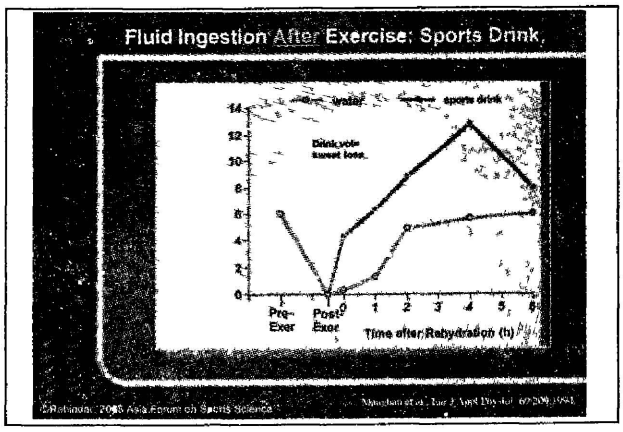
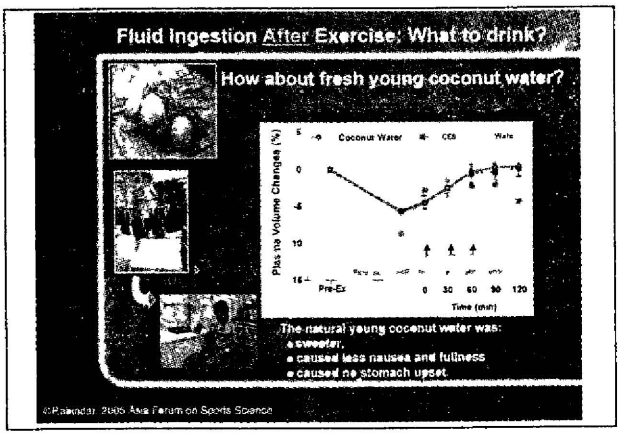

Fluid Ingestion After Exercise: What to drink?
Sports drinks
Sports drinks are beverages that contain
6-8 % carbohydrate (14-19g/240ml)
20-25 mmol of sodium (110mg/240ml)
30mg/240ml of potassium
Sports drinks are formulated with the right balance of carbohydrate and sodium for optimal hydration and taste.


Fluid Ingestion After Exercise: Sports Drink
water
sports drink
14
12
10
8
6
4
2
0
Drink vol= sweat loss
Pre-Exer
Post-Exer
0 1 2 3 4 5 6
Time after Rehydration (h)
©Rabindar 2005 Asia Forum on Sports Science


Fluid Ingestion After Exercise: What to drink?
How about fresh young coconut water?
Coconut Water
CCB
Water
Plasma Volume Changes (%)
Pre-Ex
0
30
60
90
120
Time (min)
The natural young coconut water was:
a sweeter,
caused less nausea and fullness
caused no stomach upset
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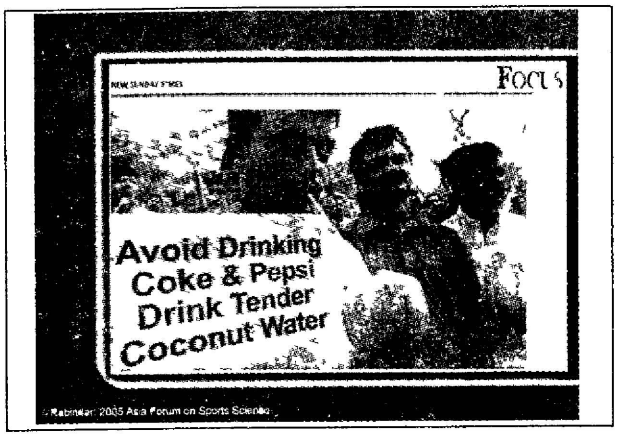
FOCUS
Avoid Drinking
Coke & Pepsi
Drink Tender
Coconut Water
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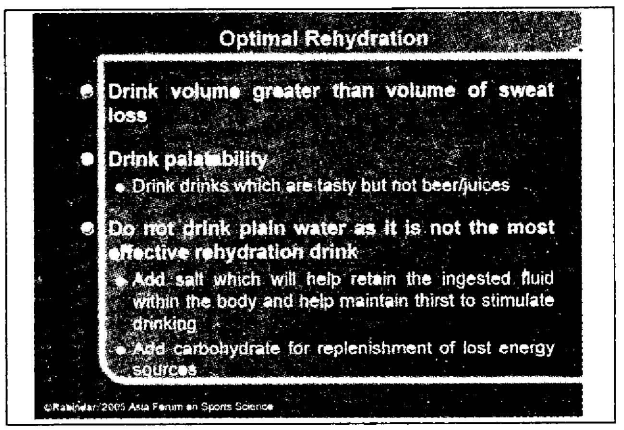
Optimal Rehydration
Drink volume greater than volume of sweat loss
Drink palatability
Drink drinks which are tasty but not beer/juices
Do not drink plain water as it is not the most effective rehydration drink
Add salt which will help retain the ingested fluid within the body and help maintain thirst to stimulate drinking
Add carbohydrate for replenishment of lost energy sources
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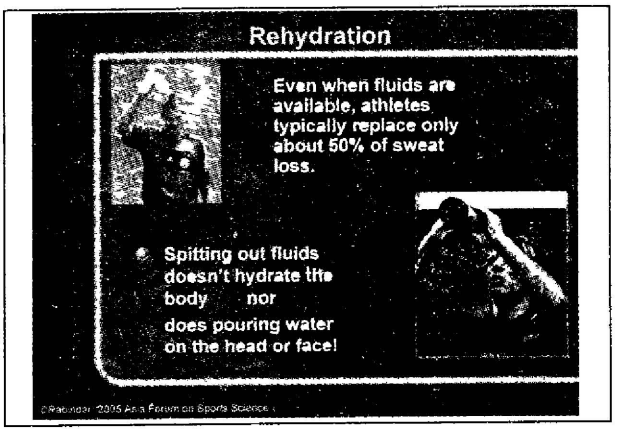
Rehydration
Even when fluids are available, athletes typically replace only about 50% of sweat loss.
Spitting out fluids doesn't hydrate the body nor
does pouring water on the head or face!
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In Summary ...
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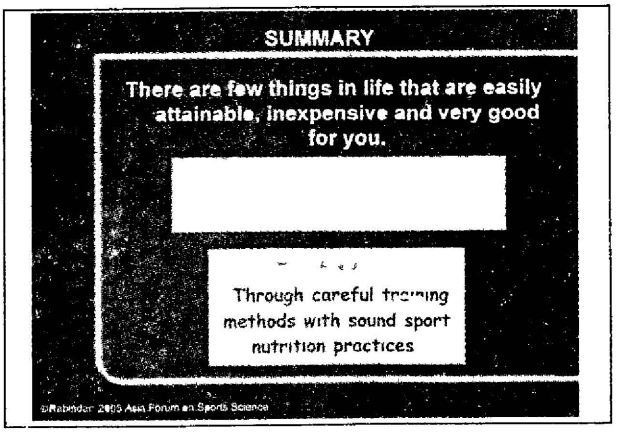
SUMMARY
There are few things in life that are easily attainable, inexpensive and very good for you.
Through careful training methods with sound sport nutrition practices
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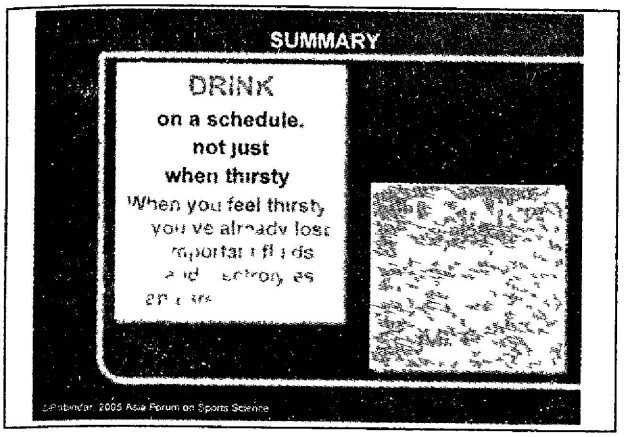
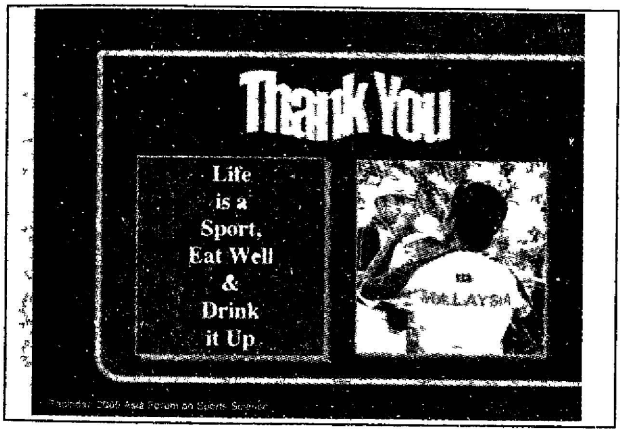

SUMMARY
DRINK
on a schedule.
not just
when thirsty
When you feel thirsty
you've already lost


Drinks should be easily available
HALF TIME


Thank You
Life
is a
Sport,
Eat Well
&
Drink
it Up