Physical activity and musculoskeletal health across the life course in Africa

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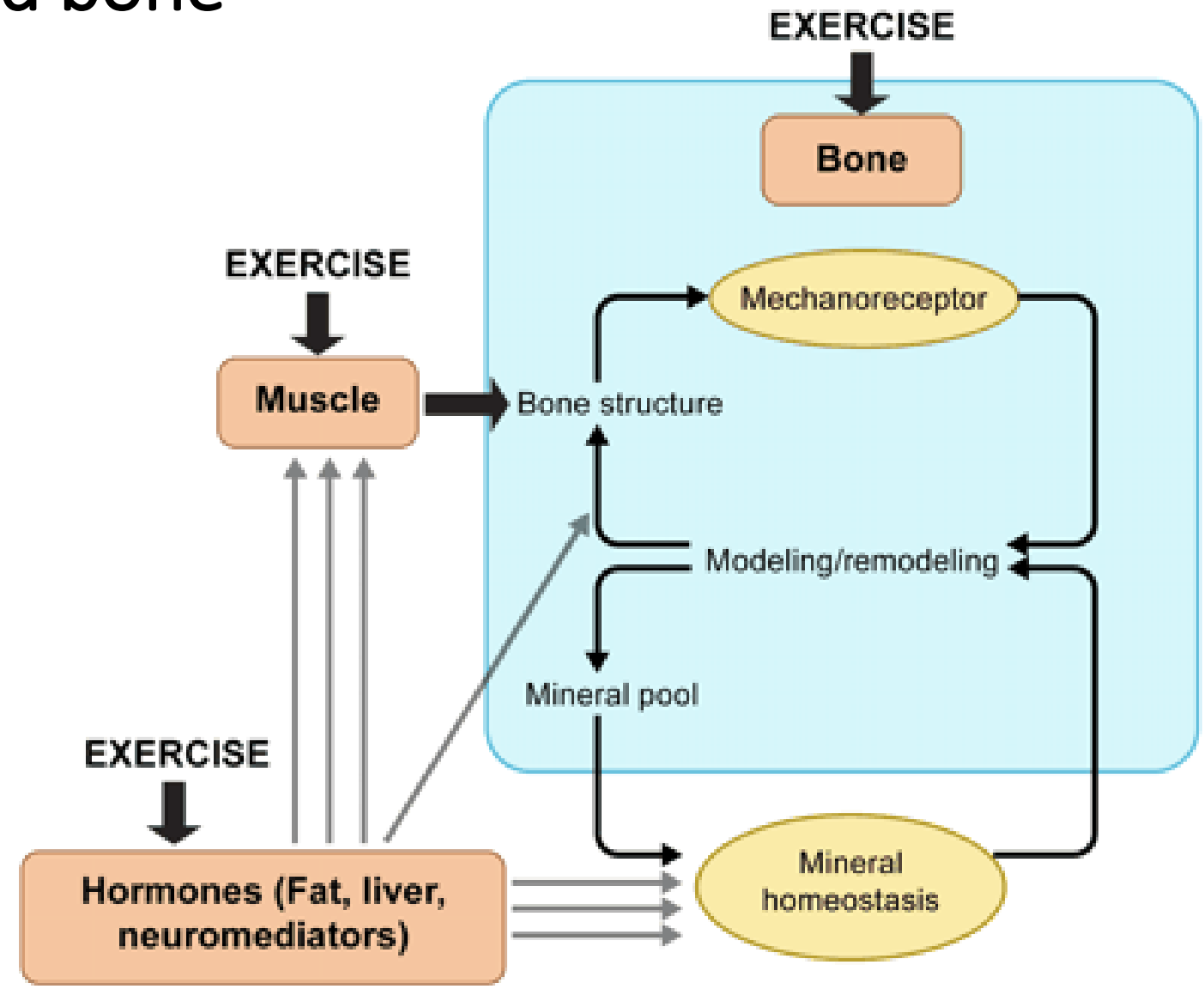
Sub-Saharan **A**frican **M**u**S**cul**O**skeletal **N**etwork (SAMSON)

Musculoskeletal Research Training Workshop, Harare, Zimbabwe

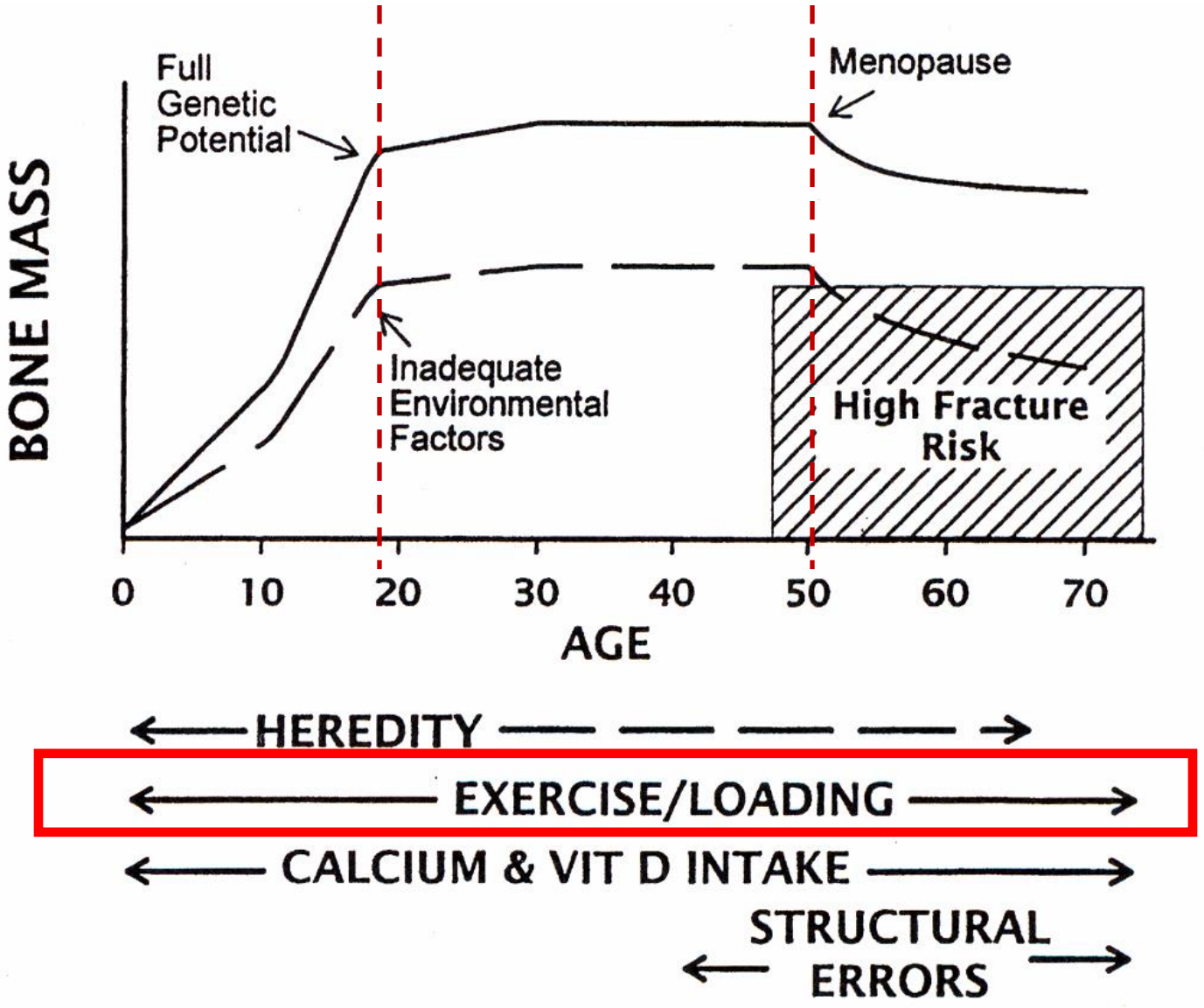
Monday 19 - Thursday 22 March 2018

Exercise and bone



Bonnet et al IBMS BoneKEy 2001; 7:235

Bone mass life line(© Robert Heaney, 1999)



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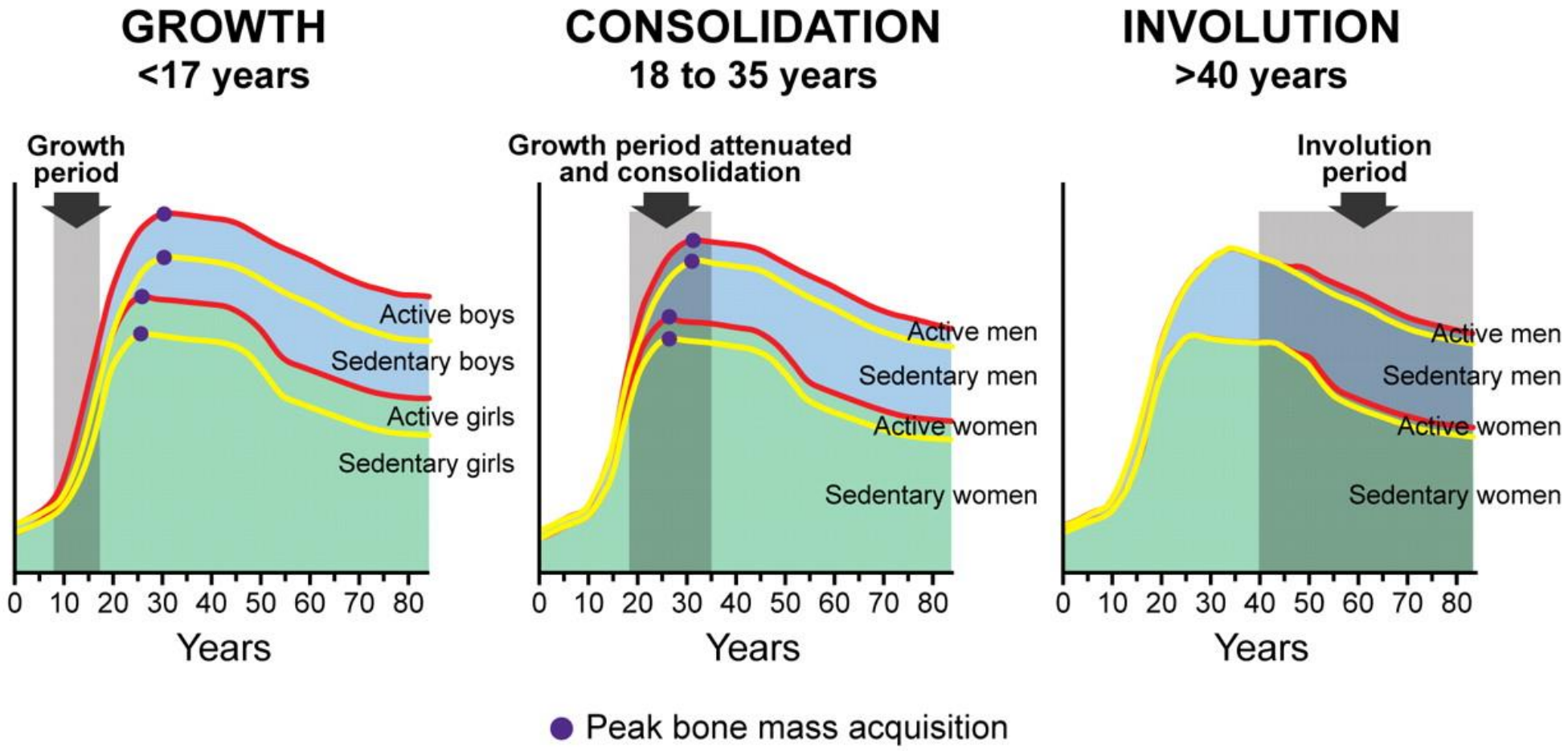


Bonnet et al IBMS BoneKEy 2001; 7:235

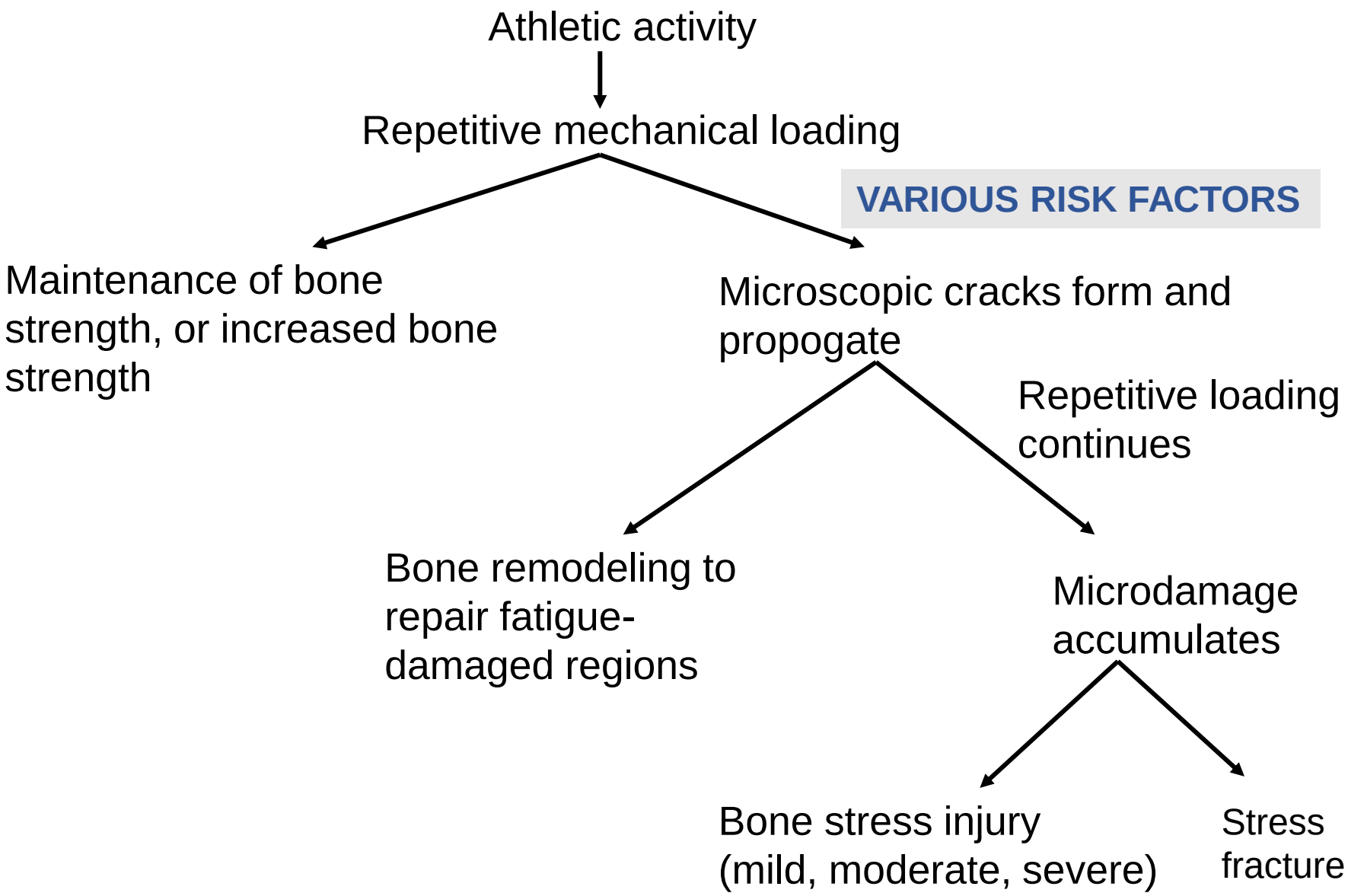
The role of exercise through the various life-stages..

1. Increase peak bone mass.

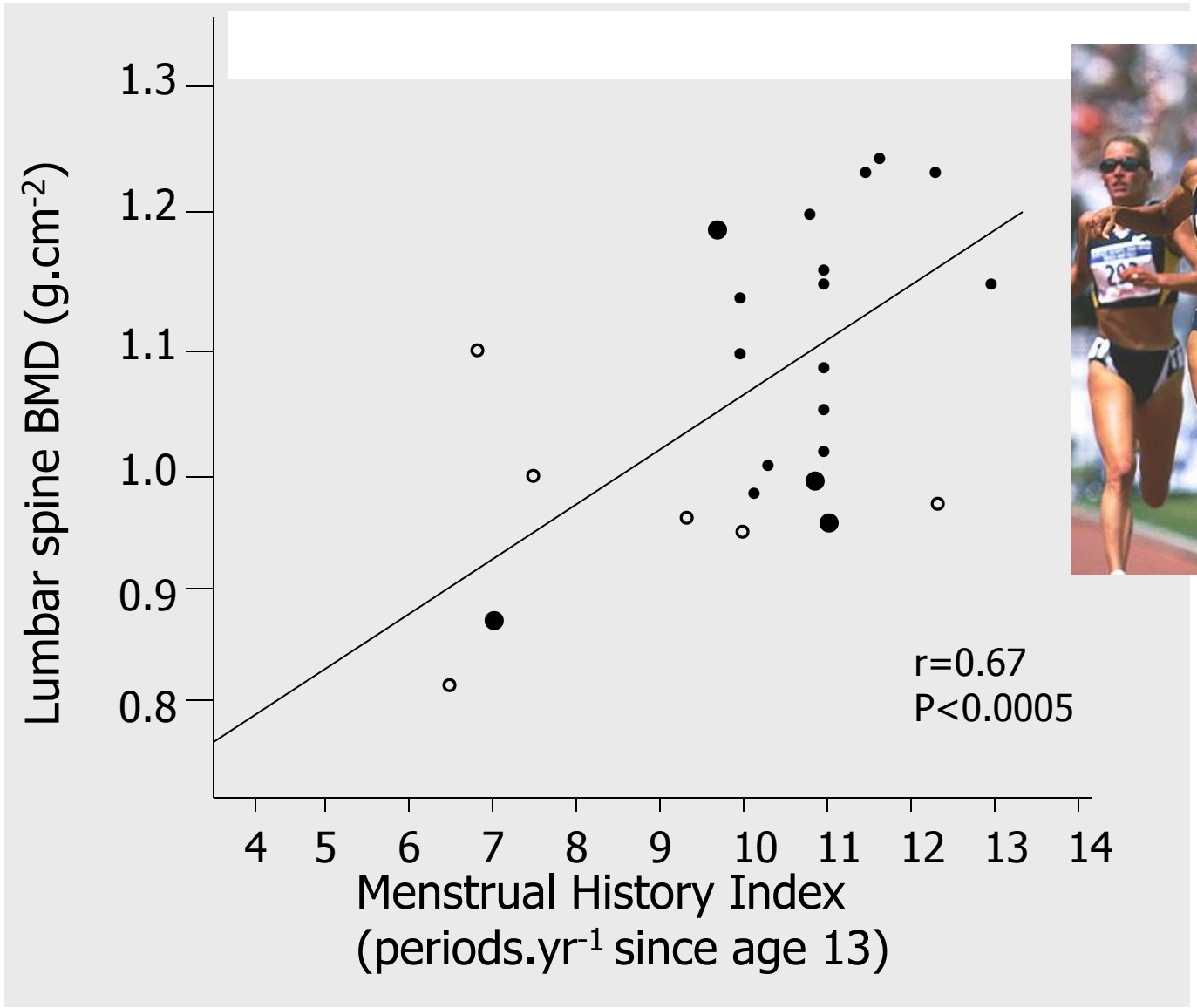
2. Minimise age-related bone loss.

3. Prevent falls and fractures.

BONE STRESS INJURY



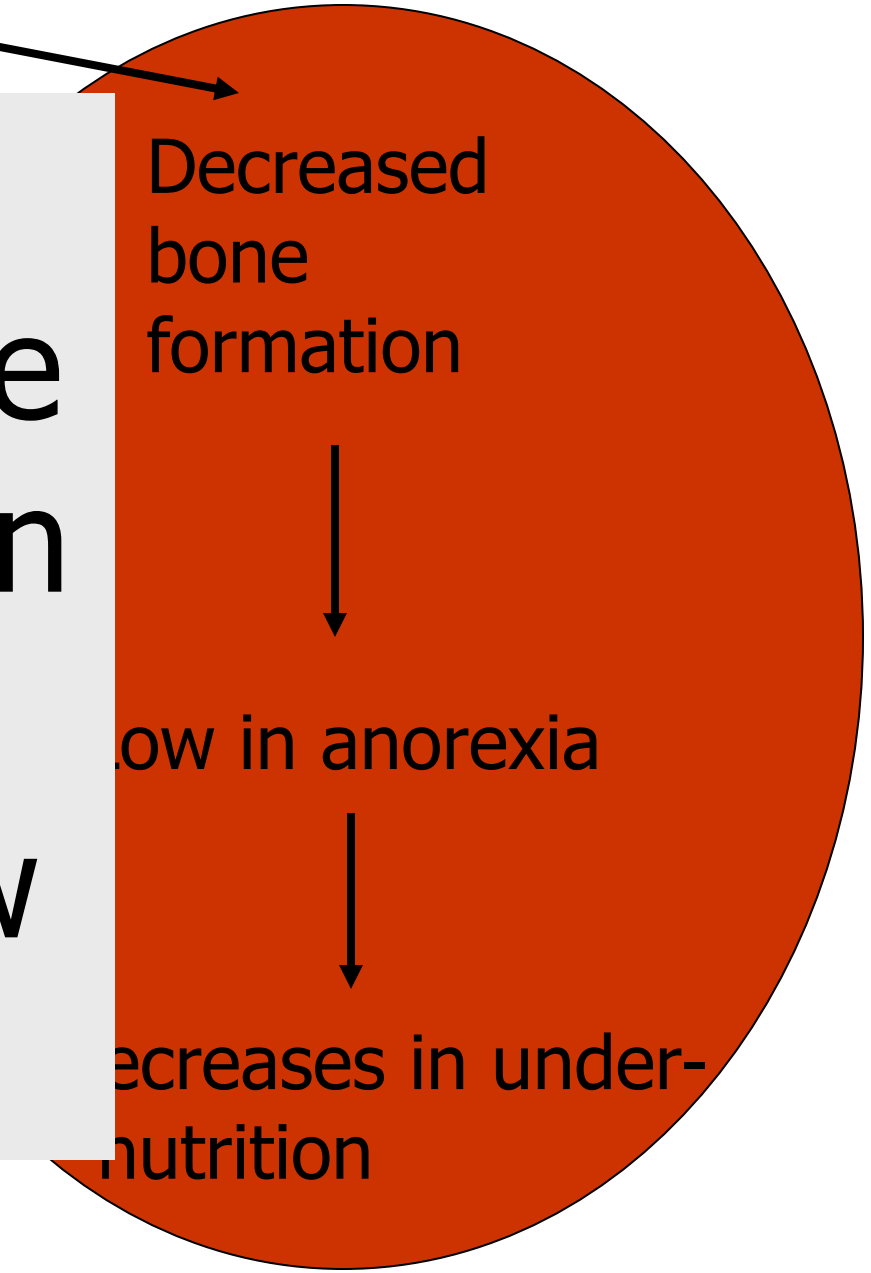
When is physical activity not beneficial to BMD?



Micklesfield et al., 1995

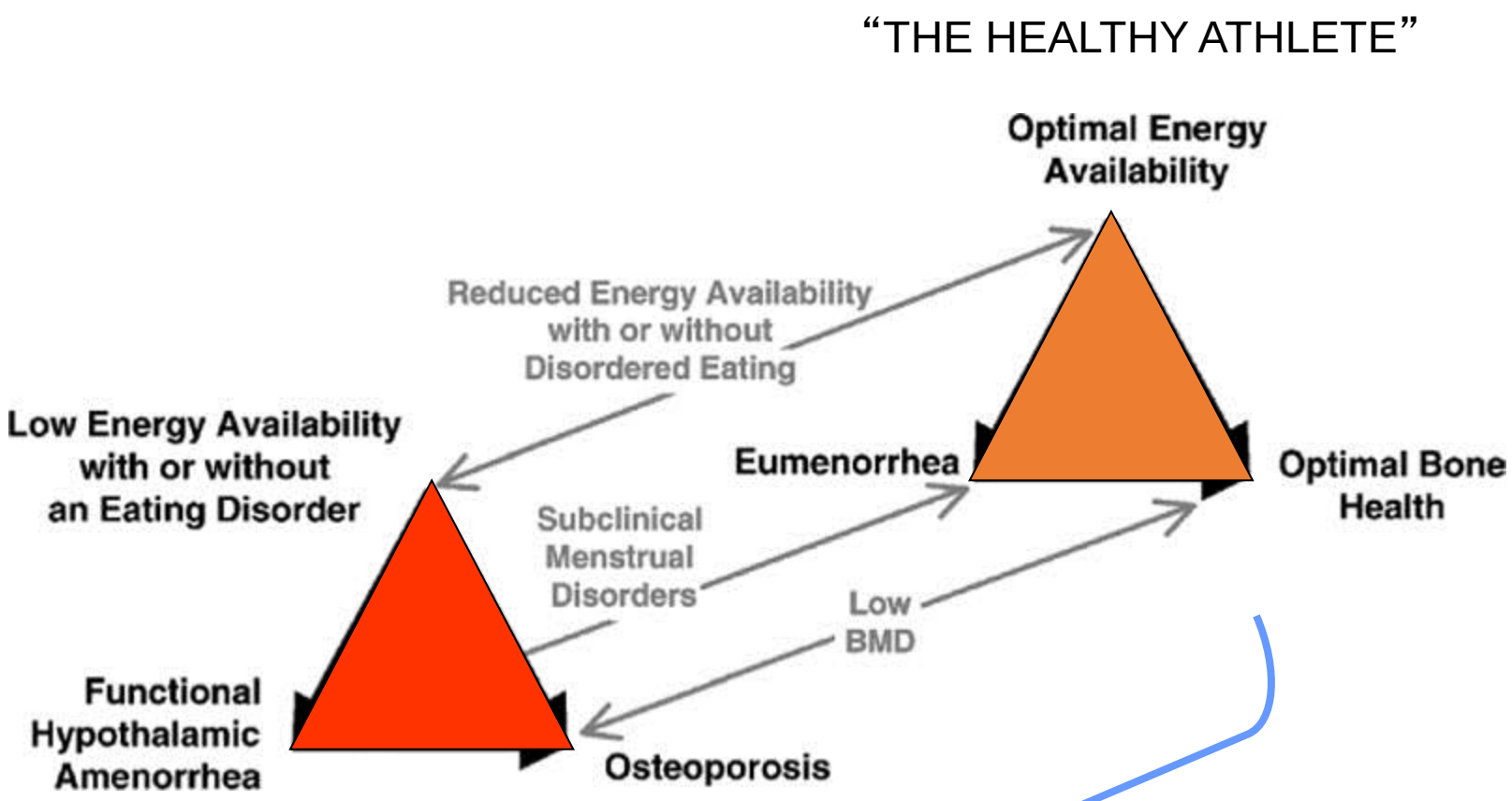
BONE TURNOVER

Exercise-associated bone loss is due to an energy deficit rather than low estrogen



deficiency

THE FEMALE ATHLETE TRIAD (2007)



The spectrums of intermediate levels of energy availability, menstrual status, and BMD where health status may be distributed

SOCIAL INEQUALITIES IN PHYSICAL ACTIVITY PARTICIPATION AND PATTERNS IN SOUTH AFRICA

	Q1 (n=115)	Q2 (n=78)	Q3 (n=78)	Q4 (n=115)
Race (% white)	0	0	0	68.7
Maternal education (% completed high school)	16.5	32.1	43.7	81.7
Support (% mothers living with partner and married)	40	41	52.1	70.4
Income (% with no cash income)	60	43.6	35.2	27.8

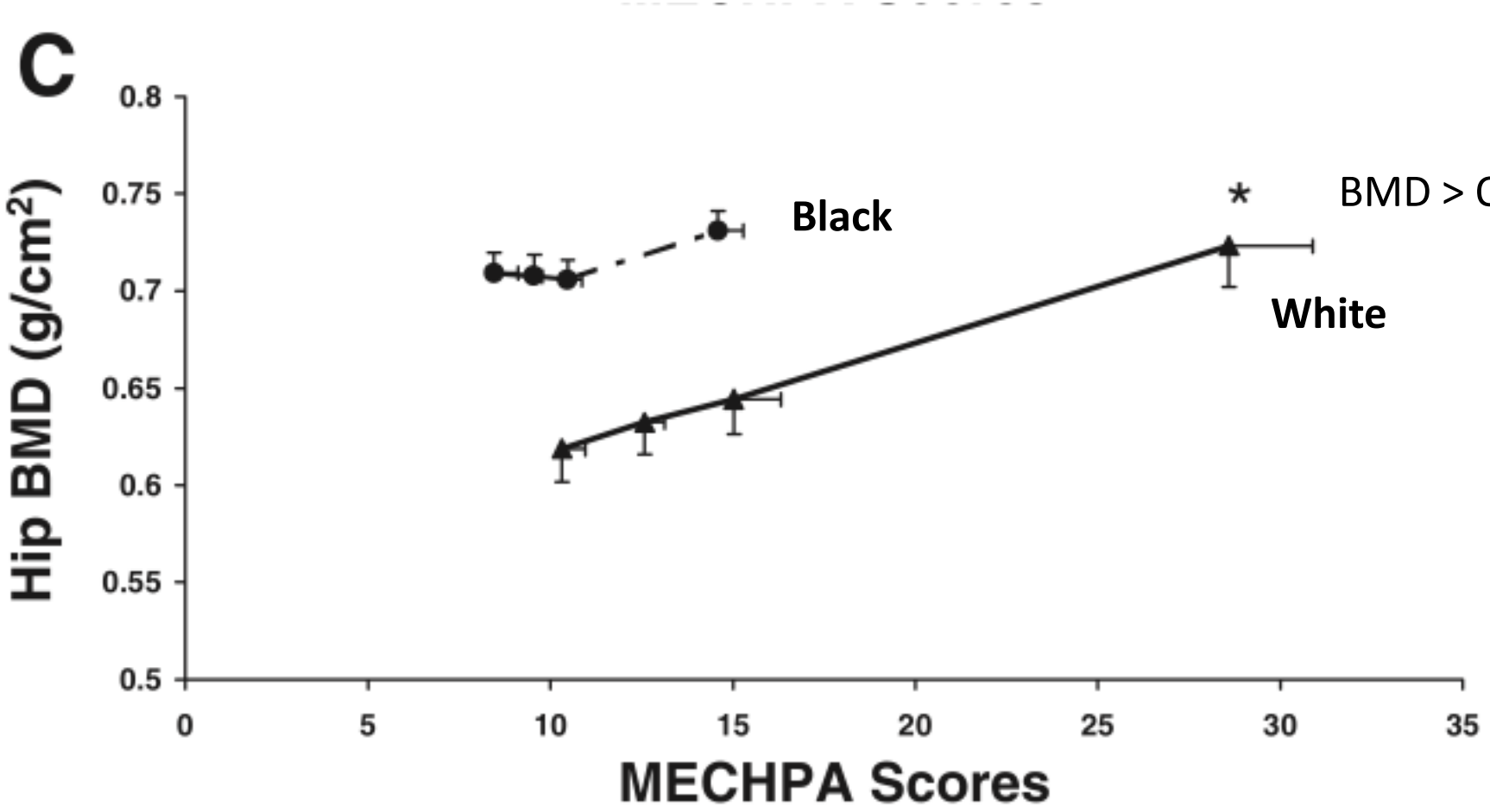
McVeigh et al., Acta Paediatr 93 (2007)

Physical activity characteristics of 9 year old SA children

	White Male (n=44)	Black Male (n=158)	White Female (n=38)	Black Female (n=146)
PE (yes)	41/44 (93%)*	43/158 (27%)	34/38 (90%)***	50/146 (34%)
Sedentary activity including sleep (hrs/day)	10.48 (0.79)	10.63 (0.33)	8.61 (0.54)	9.03 (0.34)
TV watching (hrs/wk)	17.28 (1.67)	26.54 (0.99)**	14.87 (1.75)	23.52 (1.02)****
Passive commuting (hrs/day)	0.33 (0.03)	0.4 (0.06)	0.37 (0.49)	0.47 (0.06)
Active Commuting (hrs/day)	0.03 (0.01)	0.35 (0.03)**	0.04 (0.02)	0.27 (0.03)****
Sleep (hrs/night)	10.02 (0.09)*	9.24 (0.78)	10.11 (0.14)***	9.38 (0.13)
METPA score	27.74 (5.07)*	10.65 (0.63)	14.7 (2.07)	8.39 (0.86)
MECHPA score	5.7 (1.05)*****	2.96 (0.19)	2.97 (0.56)***	2.26 (0.35)

McVeigh et al., Acta Paediatr 93 (2007)

Physical activity and bone mass in SA children



BMD > Q4 vs. Q1 and Q2

McVeigh et al., JAP 2004

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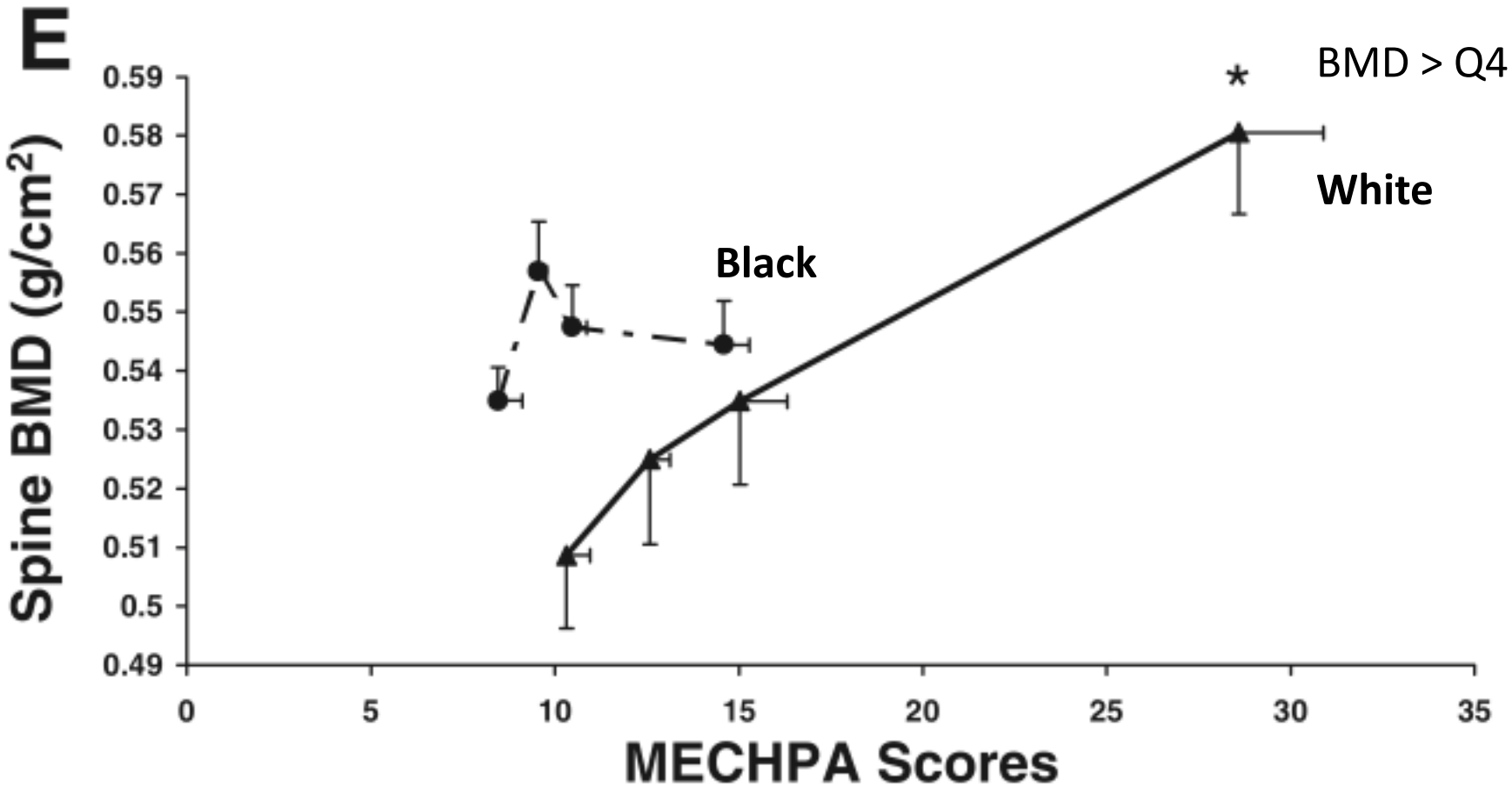


BMD > Q4 vs. Q1 and Q2

McVeigh et al., JAP 2004

Metabolic physical activity scores (METS/day) at 15 years in children with and without fractures

	Metabolic physical activity scores at 15 years (METS/day)			
	Children without fractures		Children with fractures	
	n	Mean (SD)	n	Mean (SD)
White males	24	**138 (64)**	22	**196* (83)**
White females	38	183 (106)	18	164 (65)
Black males	140	153 (53)	32	158 (66)
Black females	145	139 (46)	18	135 (33)

* **p=0.01**

Thandrayen et al., JBMR 2011

Collaboration with colleagues at the Department of Physiology (Exercise Lab), University of the Witwatersrand

J Musculoskelet Neuronal Interact 2014; 14(3):276-285

Original Article

Osteogenic effects of a physical activity intervention in South African black children

R.M. Meiring[1], L.K. Micklesfield[2], I. Avidon[1], J.A. McVeigh[1]

n=22 (EX n=12, CON n=10); 9.7 (1.1) years

20 week weight bearing exercise programme

DXA and tibial pQCT (4% and 38% sites)

This study documents for the first time the beneficial response of trabecular and cortical bone of black children to a weight bearing exercise intervention.

Results: significant group x time interaction in **hip BMC, ToD and TrbD (4% site) and CoD (38% site)**

Annals of Human Biology
Journal of the Society for the Study of Human Biology
http://tandfonline.com/iahb
ISSN: 0301-4460 (print), 1464-5033 (electronic)
Ann Hum Biol, 2016; 43(6): 520–526
 DOI: 10.3109/03014460.2015.1106009

RESEARCH PAPER

The effect of loading and ethnicity on annual changes in cortical bone of the radius and tibia in pre-pubertal children

Rebecca M. Meiring[1], Lisa K. Micklesfield[2], and Joanne A. McVeigh[1]

Aim: To determine whether the annual relative change in bone size and strength differed between high and low bone Loaders, and also between black and white pre-pubertal children.

- pQCT 65% radius and tibia; 41 black and white children (15 boys, 26 girls); 8–11 years of age, at baseline and 1 year later.
- Children were categorised into either a **high or low bone loading group** from a peak bone strain score obtained from a bone-specific physical activity questionnaire.
- There was **no difference in annual relative change** in radial or tibia bone size and strength between the low and high bone loaders.
- Black children had a greater annual relative change in CoD and SSI compared to the white children.

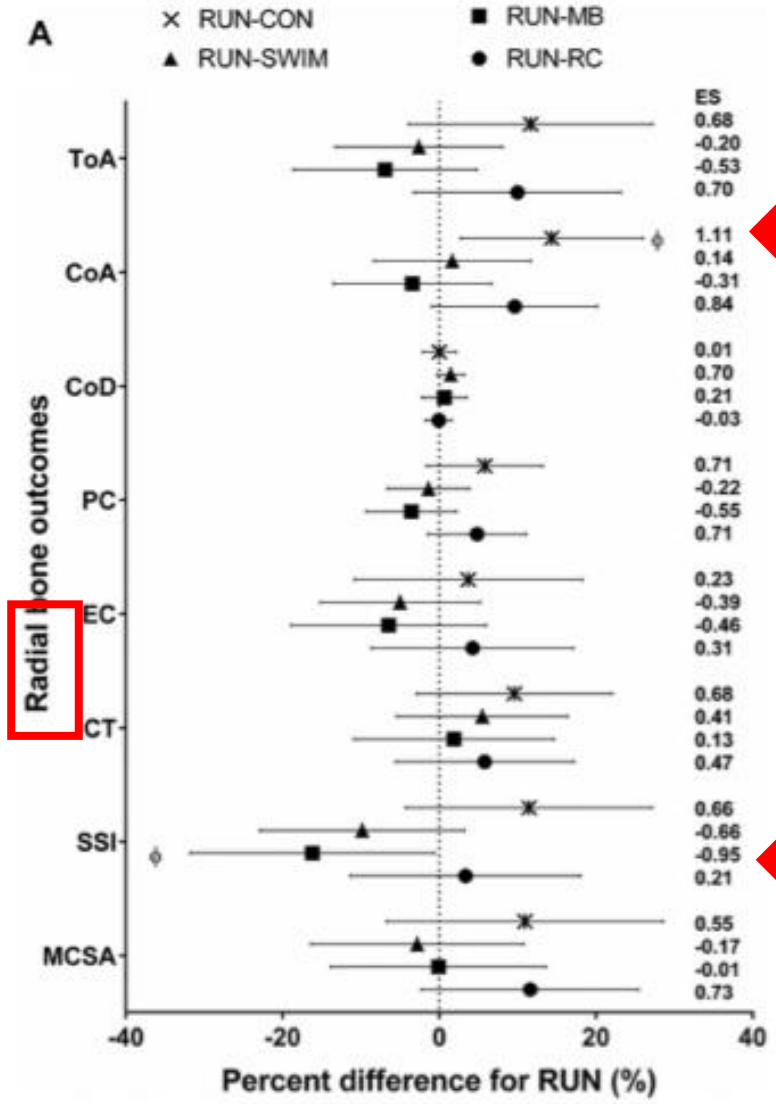
European Journal of Sport Science, 2016
http://dx.doi.org/10.1080/17461391.2016.1219770

Routledge

ORIGINAL ARTICLE

Radial and tibial bone indices in athletes participating in different endurance sports: a pQCT study†

To establish whether different sports, which impose different magnitude and types of bone loading on particular appendicular sites, will result in sport-specific bone adaptations



pQCT radial and tibial diaphyseal measures
(i) non-weight-bearing and non-impact sports:

- swimmers (SWIM, n = 13)
- road cyclists (RC, n = 10)
- mountain bikers (MB, n = 10)
- runners (RUN, n = 9)
- sedentary controls (CON, n = 10).

Oosthuyse et al., 2016

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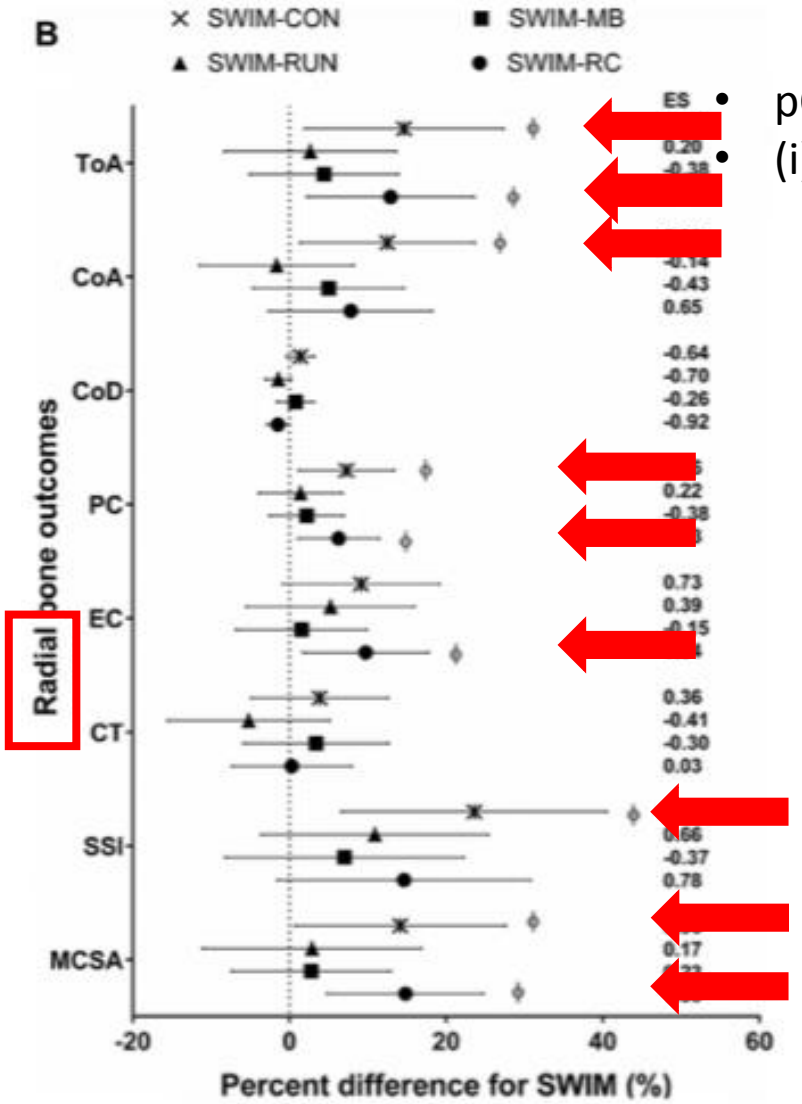

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In swimmers, the bone structure and strength of the primary exercised limbs, the arms, is greater than controls and road cyclists.

Oosthuyse et al., 2016

European Journal of Sport Science, 2016
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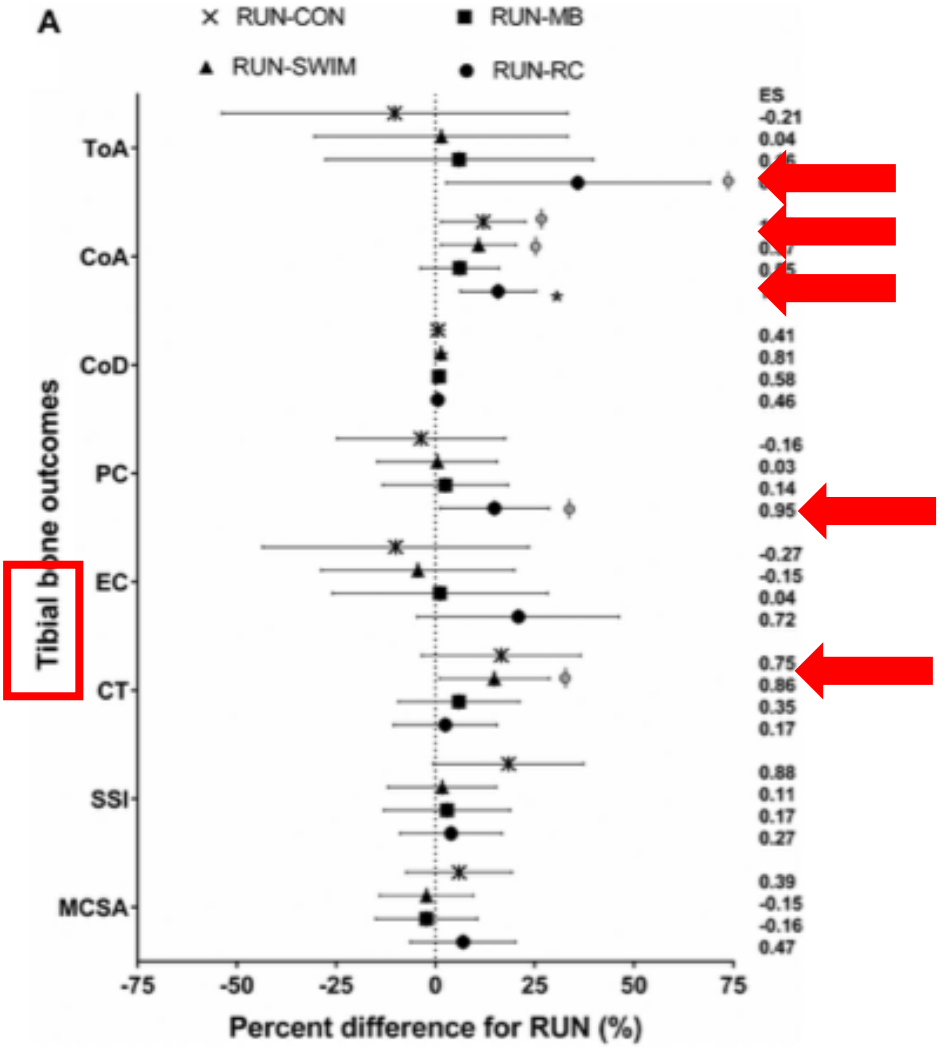

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  - runners (RUN, n = 9)
  - sedentary controls (CON, n = 10).

Runners displayed greatest bone size at the tibia compared to controls, road cyclists and swimmers

Oosthuyse et al., 2016

European Journal of Sport Science, 2016
http://dx.doi.org/10.1080/17461391.2016.1219770

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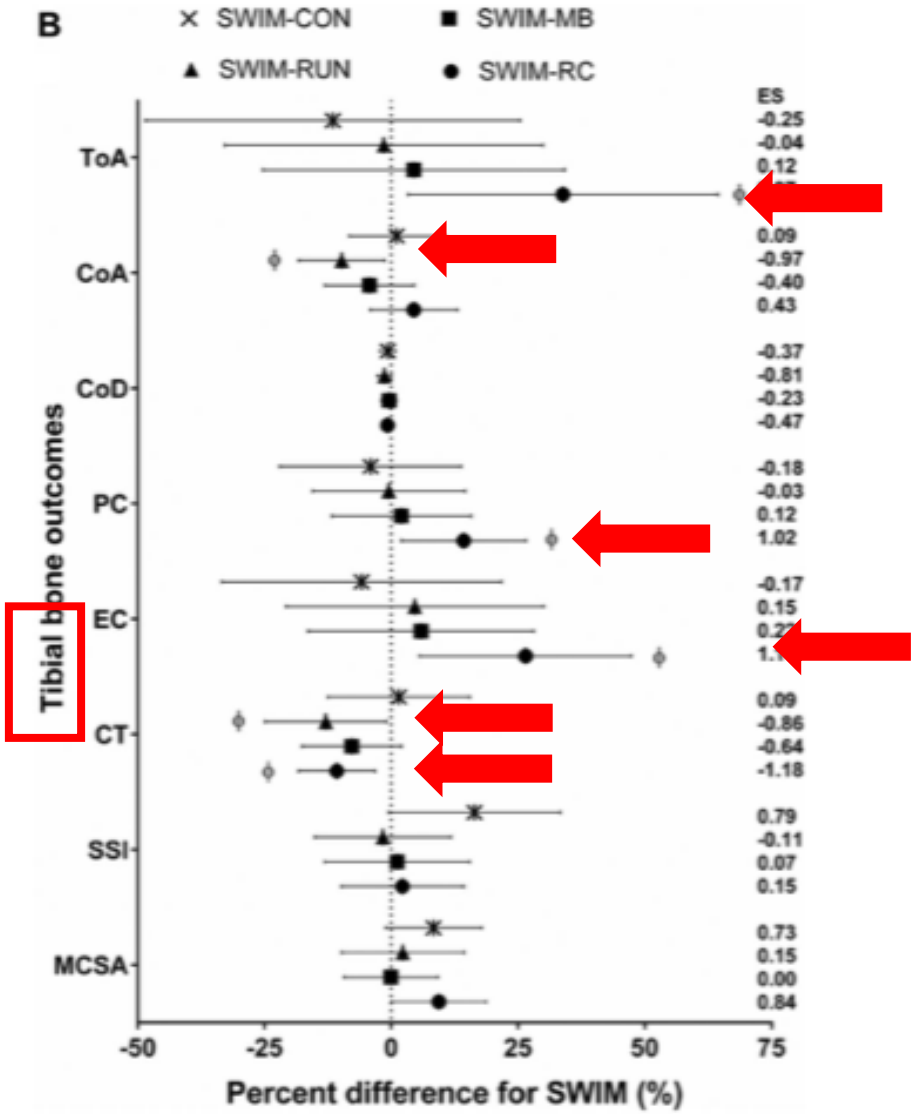

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Oosthuyse et al., 2016

European Journal of Sport Science, 2015
Vol. 15, No. 4, 332–340, http://dx.doi.org/10.1080/17461391.2014.933881

Routledge
Taylor & Francis Group

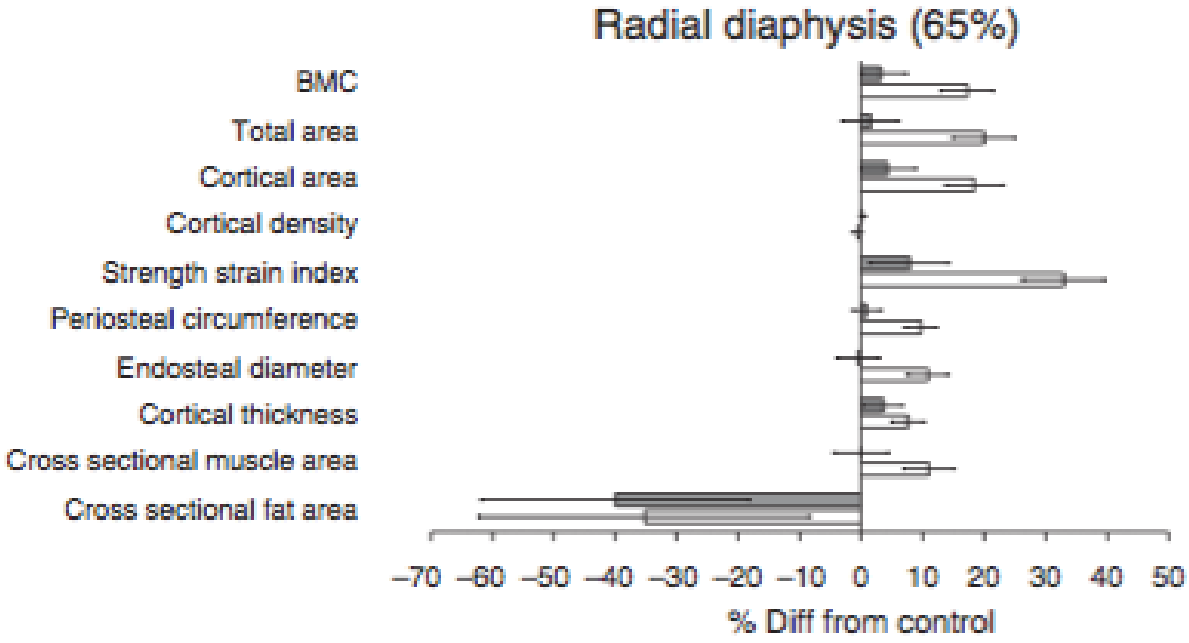
ORIGINAL ARTICLE

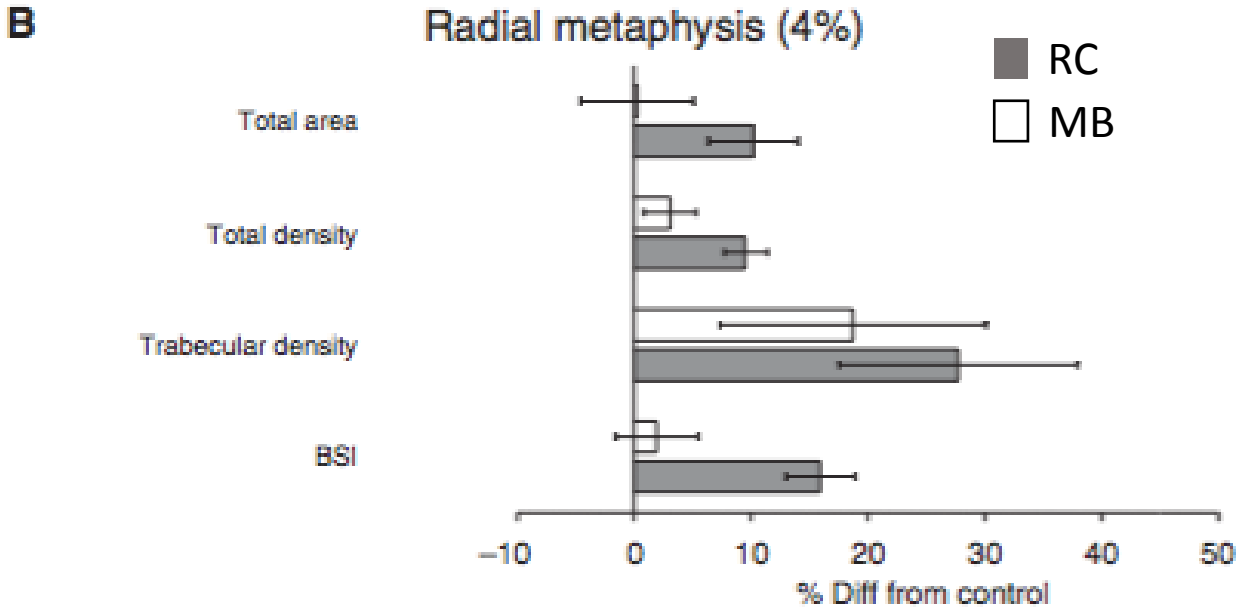
Radial bone size and strength indices in male road cyclists, mountain bikers and controls

JOANNE A. MCVEIGH[1], REBECCA MEIRING[1], ALESSANDRA CIMATO[1], LISA K. MICKLESFIELD[2], & TANJA OOSTHUYSE[1]

30 male cyclists (18–34 years);
MB (n = 10), RC (n = 10)
and non-athletes controls (CON, n = 10)
4% and 65% radius - pQCT

Bone loading, muscle size and strength of MB are superior to RC.





Calcif Tissue Int (2003) 73:463–469
DOI: 10.1007/s00223-002-2129-8

Calcified Tissue International

Bone Mineral Density and Lifetime Physical Activity in South African Women

L. Micklesfield,[1] L. Rosenberg,[2] D. Cooper,[3] M. Hoffman,[3] A. Kalla,[4] I. Stander,[5] E. Lambert[1]

Aim: to evaluate the relationship between **lifetime physical activity** patterns and BMD in middle and older-age women from the Western Cape of South Africa.

Multivariate analysis for LS BMD

Variable	b	β	*P* level
Age (yrs)	−0.205	−0.003	0.013
Total energy expenditure* (Met hrs/week)	0.215	0.0005	0.009
Weight (kg)	0.419	0.004	0.000
With household energy expenditure* in place of total energy expenditure[2]			
Age (yrs)	−0.190	−0.003	0.0183
Household energy expenditure* (Met hrs/week)	0.255	0.0012	0.0015
Weight (kg)	0.418	0.004	0.000

[1] $R = 0.480$, adjusted $R^2 = 0.211$, SEE = 0.125, $P < 0.0001$, β, parameter estimate; b, partial coefficient
[2] $R = 0.500$, adjusted $R^2 = 0.231$, SEE = 0.124, $P < 0.0001$, β, parameter estimate; b, partial coefficient
* Between 14 and 21 years of age

Micklesfield et al., CTI 2003

Osteoporos Int (2012) 23:533–542
DOI 10.1007/s00198-011-1570-9

ORIGINAL ARTICLE

Site-specific differences in bone mineral density in black and white premenopausal South African women

S. Chantler · K. Dickie · J. H. Goedecke · N. S. Levitt · E. V. Lambert · J. Evans · Y. Joffe · L. K. Micklesfield

	Black women (n =240)	White women (n =187)	P value
Sociodemographics			
Unemployment (%)	38.1	5.8	<0.001
Education (% completed grade 12)	58.1	95.2	<0.001
Education (% completed tertiary education)	19.2	74.3	<0.001
Housing density (persons/room)	1 (0.6–1.4)	0.44 (0.3–0.6)	0.504
Women who consume alcohol (%)	32.1	74.1	<0.001
Smokers (%)	7.9	17.1	0.003
Physical activity			
Total activity (MET min/day)	206 (74–480)	206 (57–411)	0.298
Total vigorous activity (MET min/day)	0 (0–0)	103 (0–206)	<0.001
Total moderate activity (MET min/day)	171 (51–480)	51 (0–206)	<0.001
Travel activity (MET min/day)	120 (26–240)	0.9±0.1	<0.001
Women who walk for travel (%)	78.5	24.0	<0.001
Work activity (MET min/day)	0 (0–0)	0 (0–0)	0.836
Leisure activity (MET min/day)	0 (0–62)	154 (51–274)	<0.001

Multiple regression analyses for BMD in black and white premenopausal South African women

	β	B	SEE	P value
Black women				
Femoral neck				
FFSTM (kg)	0.633	0.013	0.001	0.000
Injectable contraceptive use	−0.229	−0.066	0.017	0.000
Tertiary education	0.102	0.033	0.018	0.075
	R=0.645	R^2=0.416	Adj R^2=0.406	
Total hip				
FFSTM (kg)	0.567	0.012	0.001	0.000
Injectable contraceptive use	−0.178	−0.052	0.018	0.004
Tertiary education	0.105	0.035	0.020	0.086
	R=0.575	R^2=0.331	Adj R^2=0.320	
Lumbar spine				
FFSTM (kg)	0.369	0.007	0.001	0.000
Injectable contraceptive use	−0.182	−0.049	0.017	0.007
Tertiary education	0.192	0.058	0.020	0.004
Walk for travel	−0.141	−0.040	0.018	0.031
	R=0.471	R^2=0.222	Adj R^2=0.205	
White women				
Femoral neck				
FFSTM (kg)	0.429	0.007	0.001	0.000
Leisure activity (log MET min/day)	0.211	0.066	0.023	0.004
	R=0.493	R^2=0.243	Adj R^2=0.232	
Total hip				
FFSTM (kg)	0.482	0.009	0.001	0.000
Leisure activity (log MET min/day)	0.227	0.076	0.023	0.001
	R=0.55	R^2=0.303	Adj R^2=0.293	
Lumbar spine				
Fat mass (kg)	0.156	0.001	0.001	0.060
Leisure activity (log MET min/day)	0.242	0.070	0.024	0.004
Oral contraceptive use	−0.176	−0.041	0.019	0.033
	R=0.335	R^2=0.112	Adj R^2=0.093	

- FN and TH BMD were higher, but LS BMD was lower in black than white South African women
- Body composition, lifestyle and SES factors contributing differently to BMD in these women.

Chantler et al., Osteo Int. 2012

Conclusions

Understanding PA's impact on bone mass is central to developing primary prevention strategies for osteoporosis but needs to consider:

- Differences in physical activity patterns;
- Site-specific loading;
- Contribution of factors in different ethnic groups

Thank you