Effect of Enriched Snacks *(Moringa oleifera)* on Neurobehavioral Outcomes among 3-4 year old children in Malolos Day Care Centers

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Research Support

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- Philippine Pediatric Society
- PCHRD, DOST

Malnutrition is still a problem in the Philippines

- 8th National Nutrition Survey
  - Underweight -19.9% (from 20.2%)
  - Wasting -7.9% (from 7.3%)
  - Stunting – 30.3% (from 33.6%)
- Highest rates of underweight and stunting at 3-4 years of age

Long Term Effects of Malnutrition

- Decreased cognitive capacity
- Decreased scholastic achievement
- Reduction of the human capital
- Reduction in the gross domestic product of the country ($6.6B/year or 6% of the GDP)

Early Malnutrition and IQ

- Undernutrition at an early age affects brain growth and IQ
- Malnutrition at 3 years old associated with
  - poor neurophysiologic performance at 11 years old
  - IQ deficit as high as 15.3 points

Improvement in nutrition in early childhood

- Increase in adult size
- Increase schooling among women
- Increased reading comprehension and intelligence in both genders
- Economic productivity
- Wages increase among men by 46%

IQ scores of the Filipino Child

- In a study by Ostrea, Reyes, Uy, et al (2013):
  - IQ score of 4-6 years old were 1 SD from the norm (83.6 & 83.9 at 4 and 6 years old)
- Based on the Flynn effect, the IQ score of a country should increase by 2 pts every 10 years
- In the Philippines, IQ scores in
  - 1970- 86
  - 2013- 83.9

Effect of School/Community Feeding

- Guatemalan 25-year cohort
  - Food supplementation program up to 2 years of age
  - Protein and iron supplement vs. fortified supplement
  - Results
    - Higher reading comprehension
    - Higher grade attainment

Effect of School/Community Feeding

- COHORTS study (Brazil, Guatemala, Philippines, India and South Africa)
  - Higher grade attainment
  - Higher linear growth

- Association does not hold true for later ages (>2-4 years old) EXCEPT in the Philippines which has upper limit of 8 years old

Proposed food fortification strategy

- Provide 1/3 RENI of Protein and Iron
- Source of iron: Malunggay (Moringa oleifera)
  - Ubiquitous, tropical plant
  - 100 grams of dried malunggay leaves will have
    - 206 calories
    - 27 grams protein
    - 28.2 mg iron

Objective:

- To determine if snacks primarily fortified with malunggay for 10 months in children in day care centers will lead to an:
  - increase in their physical growth.
  - improvement in their neurobehavioral functions,
  - improvement in their hematocrit, hemoglobin, total serum protein and serum albumin.

Study Population

- The study population will consist of 3-4 year old children in the barangay day care centers of Malolos, Bulacan
- Rationale for age group:
  - Age group not frequently seen by health provide for well baby check ups since their primary immunizations already completed.
  - Age group often do not meet adequate nutritional needs
  - More standardized neurodevelopmental tests can be administered
  - Barangay daycare centers provide a stable location where the children can be monitored & assessed for a longer duration

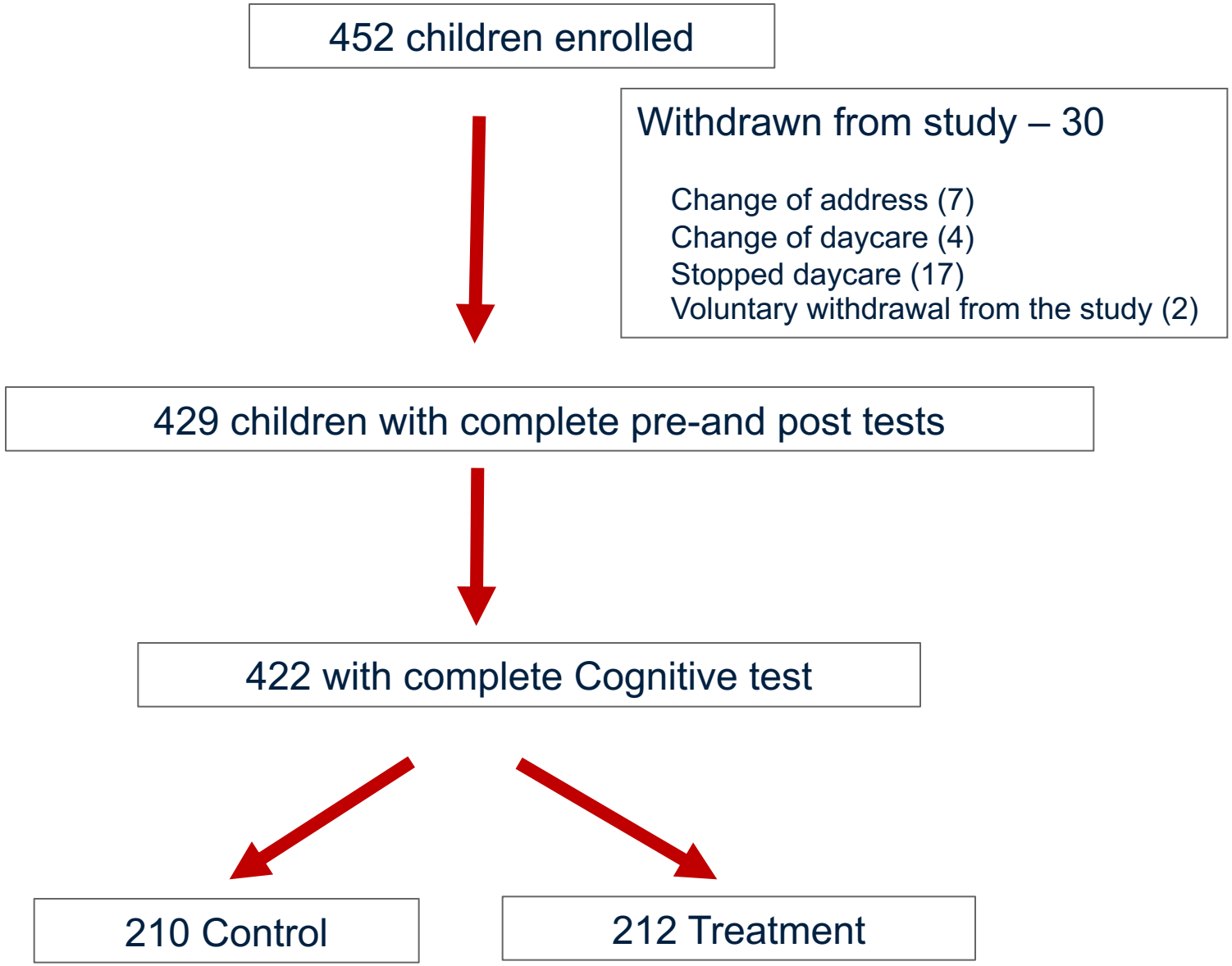
Study Design

- Single Blind Randomized Controlled Trial
- Sample size:
  - To achieve a 95% level of significance and power of 80%, change in IQ by 4 points, effect size of 1.5 and drop out rate of 5%
  - 222 per group
- Sampling Design: Cluster Sampling
  - Randomized 8 daycare centers to either the treatment (T) or control group (C).

Intervention

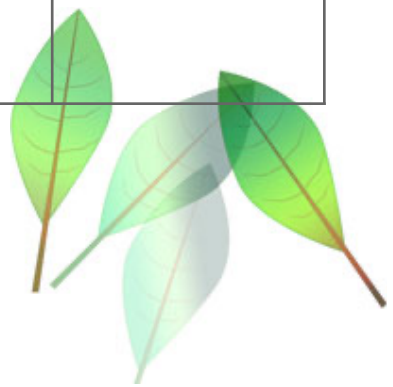
- T group
  - 1/3 RENI for iron and protein
  - 9 grams of dried malunggay powder & 38 g protein in their snacks during school days
  - Received DSWD funded snack prepared by teachers and parents
- C group
  - Receive the DSWD funded snack prepared by teachers and parents

RESULTS


452 children enrolled
Withdrawn from study – 30
Change of address (7)
Change of daycare (4)
Stopped daycare (17)
Voluntary withdrawal from the study (2)
429 children with complete pre-and post tests
422 with complete Cognitive test
210 Control
212 Treatment

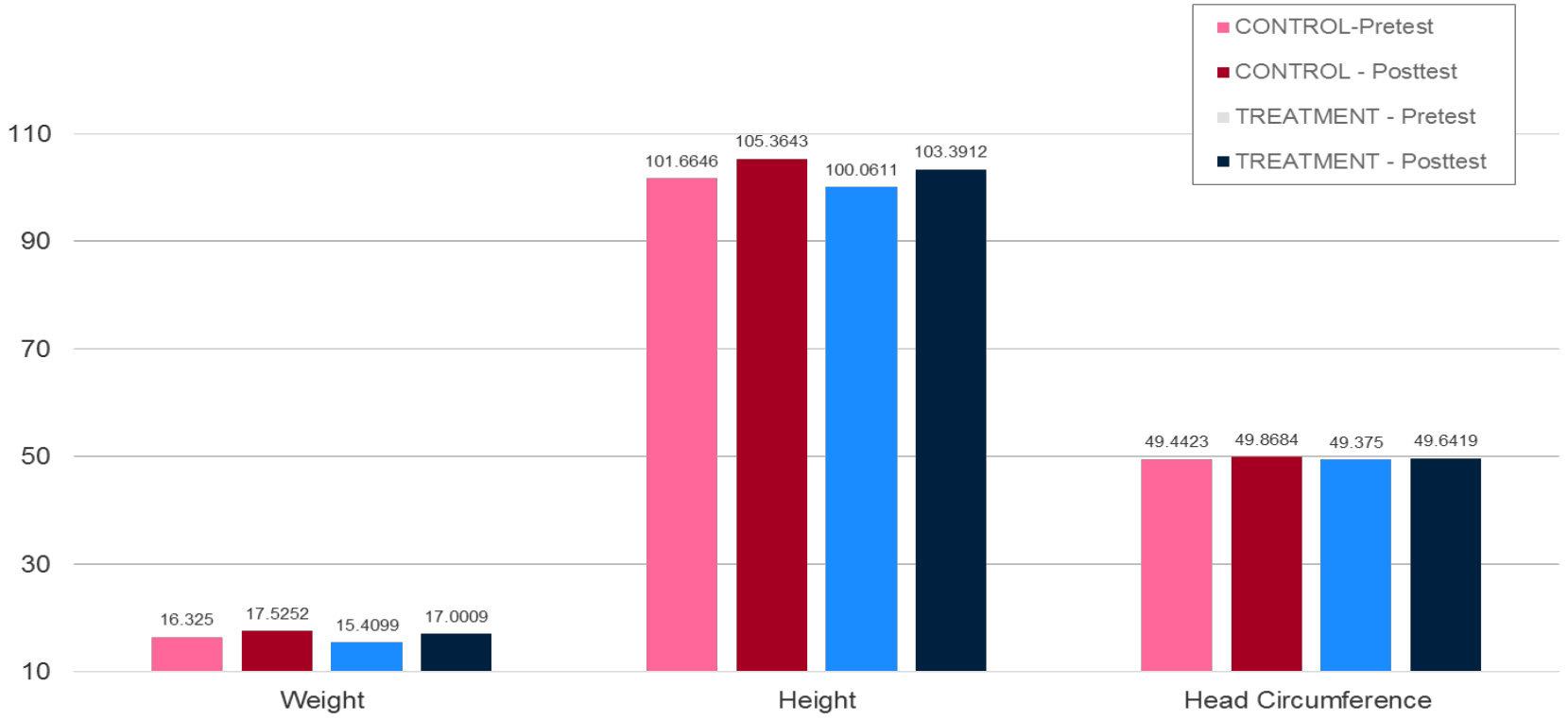
Baseline Characteristics	Control (212)	Treatment (216)	p-value
Age	4.2 ±.46	3.9 ±.48	0.00
Male Sex	49.1%	49.7%	0.88
Weight	16.3±3.92	15.4±2.85	0.006
Height	101.7±5.29	100.0±5.48	0.002
Head Circumference	49.4±1.71	49.4±1.40	0.658
Serum lead levels	1.84±5.14	7.57±15.3	0.00
Mother's Age	30.4±16.70	28.5±19.73	0.59
Socio-economic status score*	2.09±.533	2.13±.533	0.42

** SES: 1 – lowest to 5 - highest*



ANTHROPOMETRY

Comparison of PRETEST VALUES between CONTROL & TREATMENT groups



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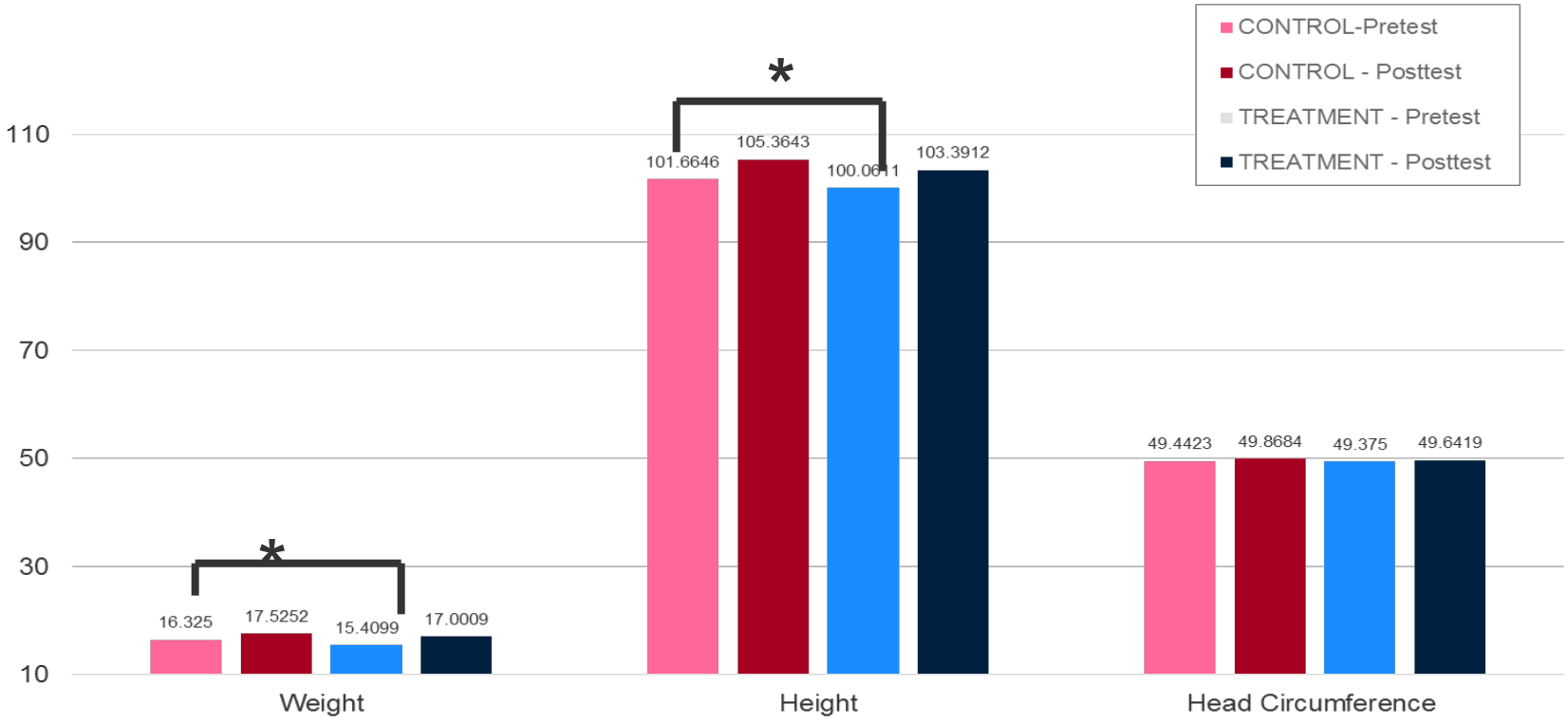
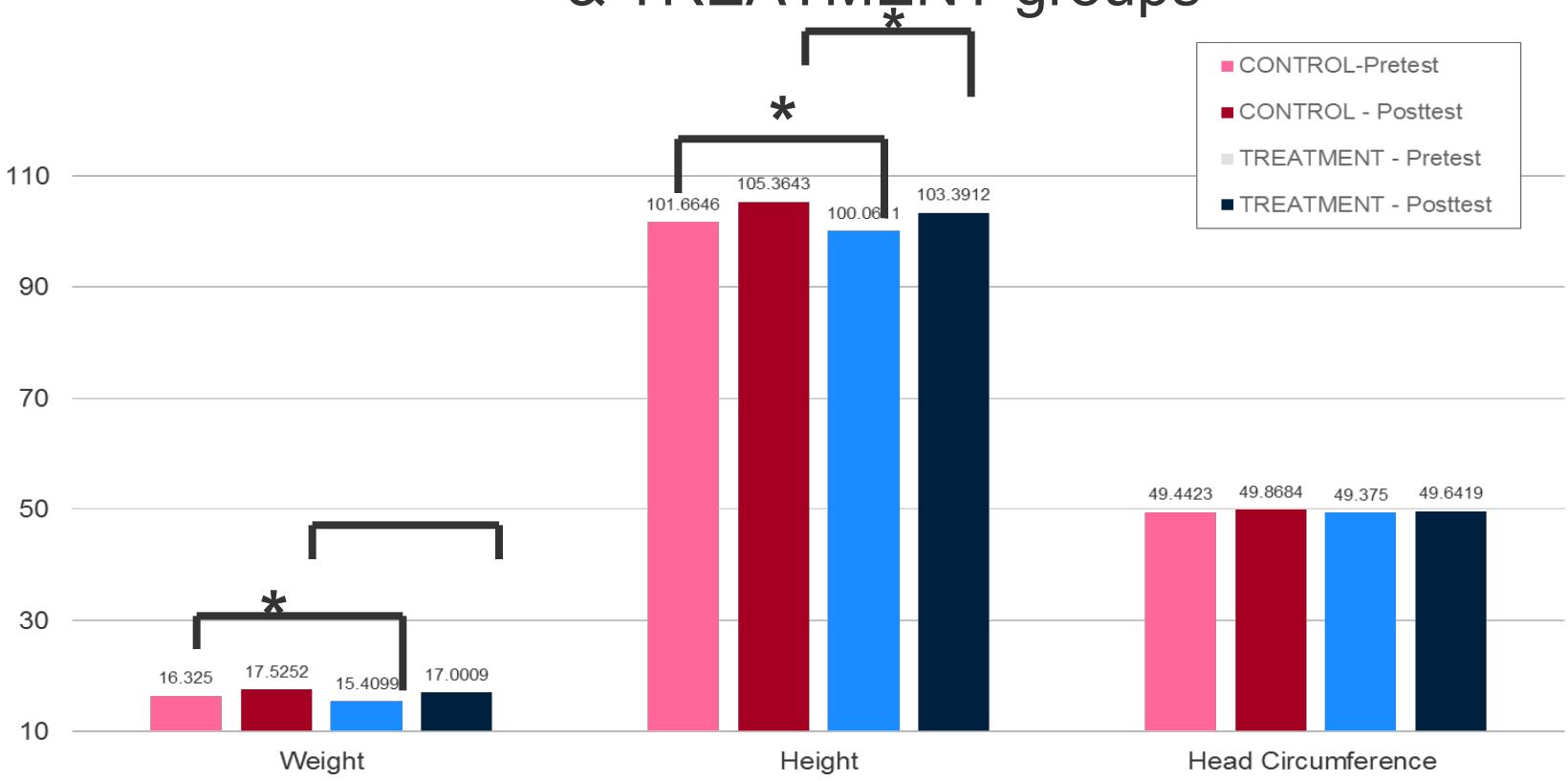


At the start: Children in the Control group were significantly heavier (1 kg) and taller (1.6 cm) than the treatment group.

ANTHROPOMETRY

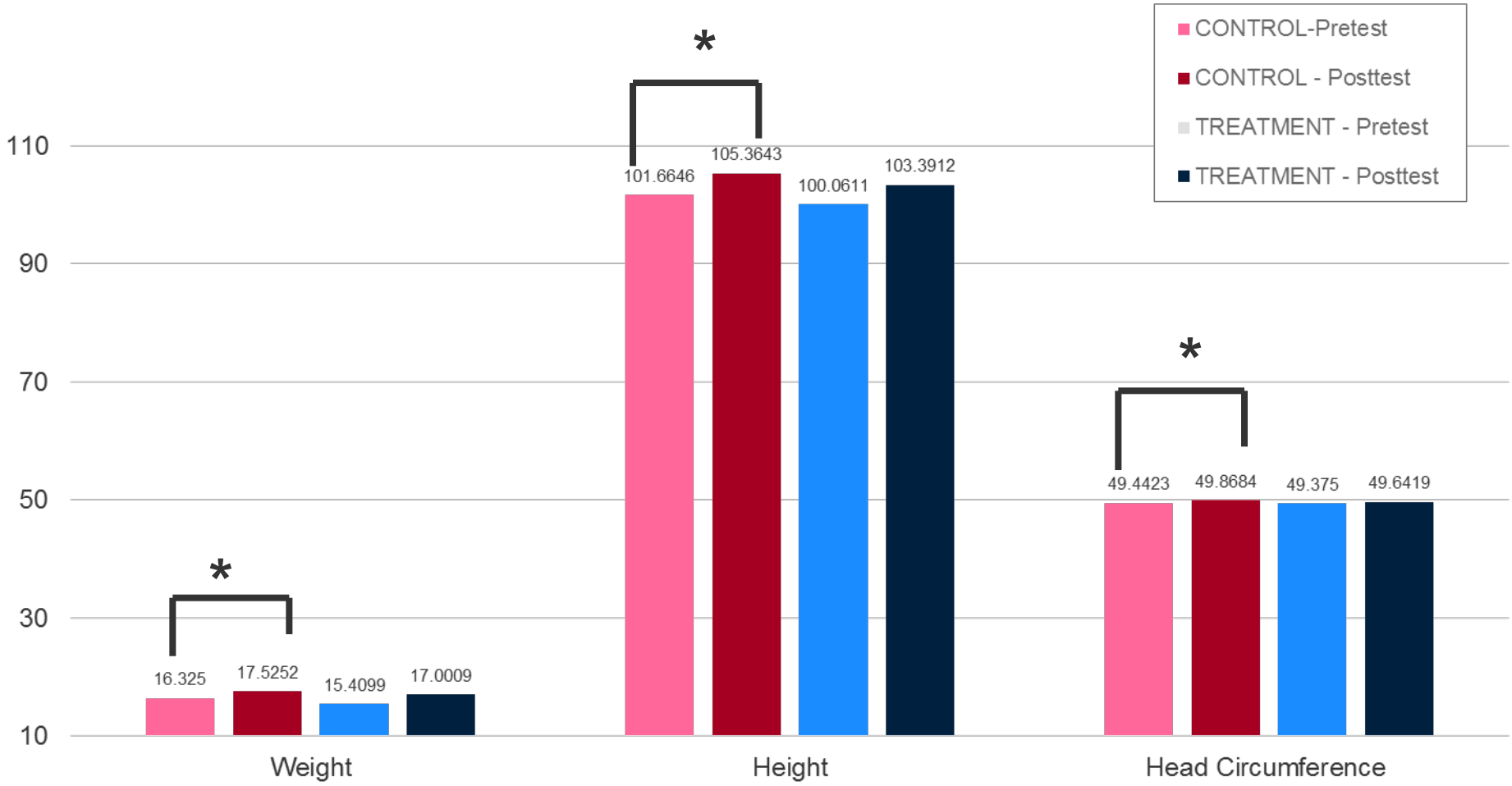
Comparison of POSTTEST VALUES between CONTROL & TREATMENT groups



At the end of the study, there was no significant difference in weight. Still, the control group was taller (2 cm) than the Tx group.

ANTHROPOMETRY

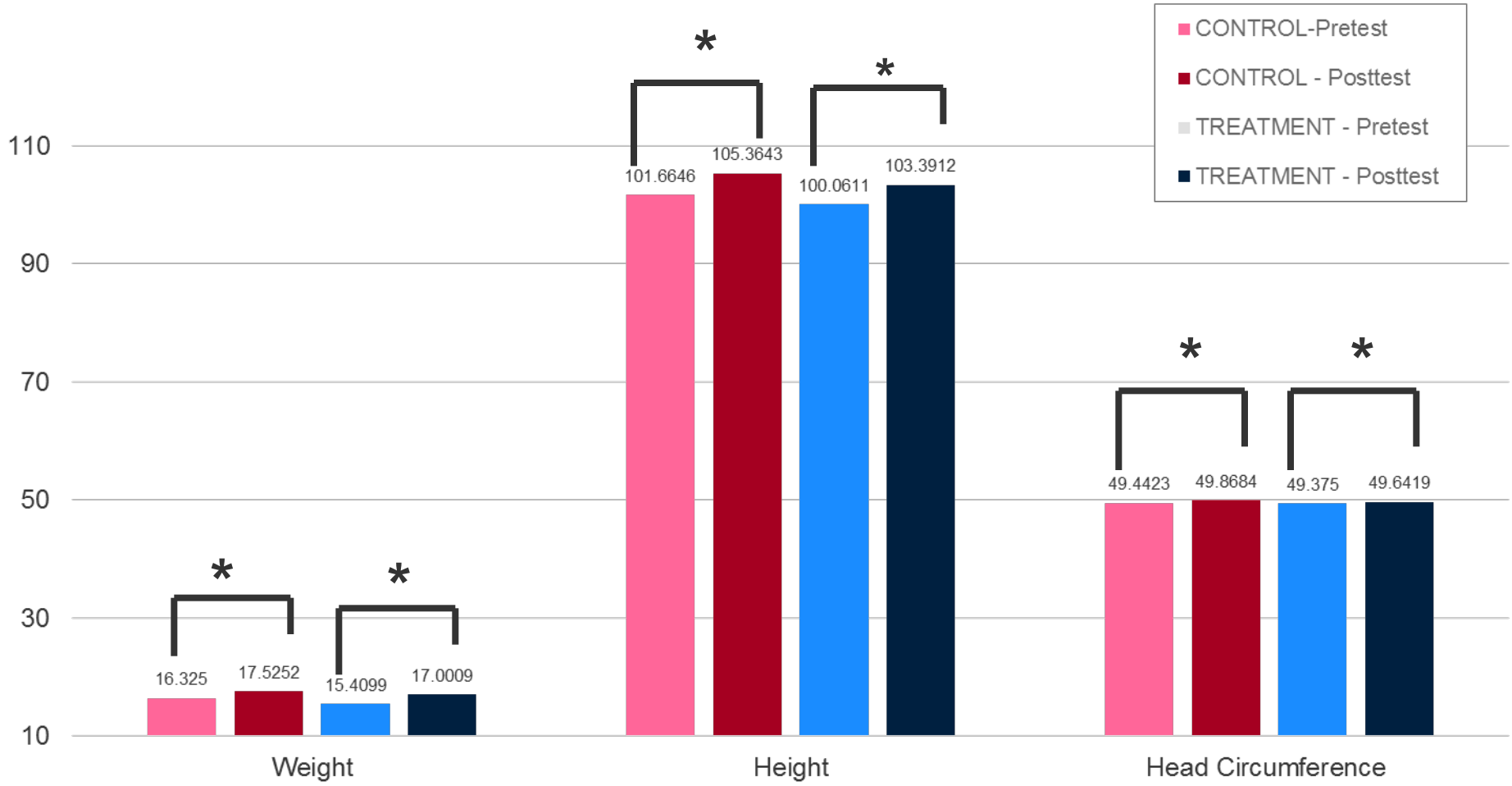
Comparison of PRE- and POST-TEST within Control & Treatment groups



There was a significant increase in weight, height and HC among control group at the start and end of the study.

ANTHROPOMETRY

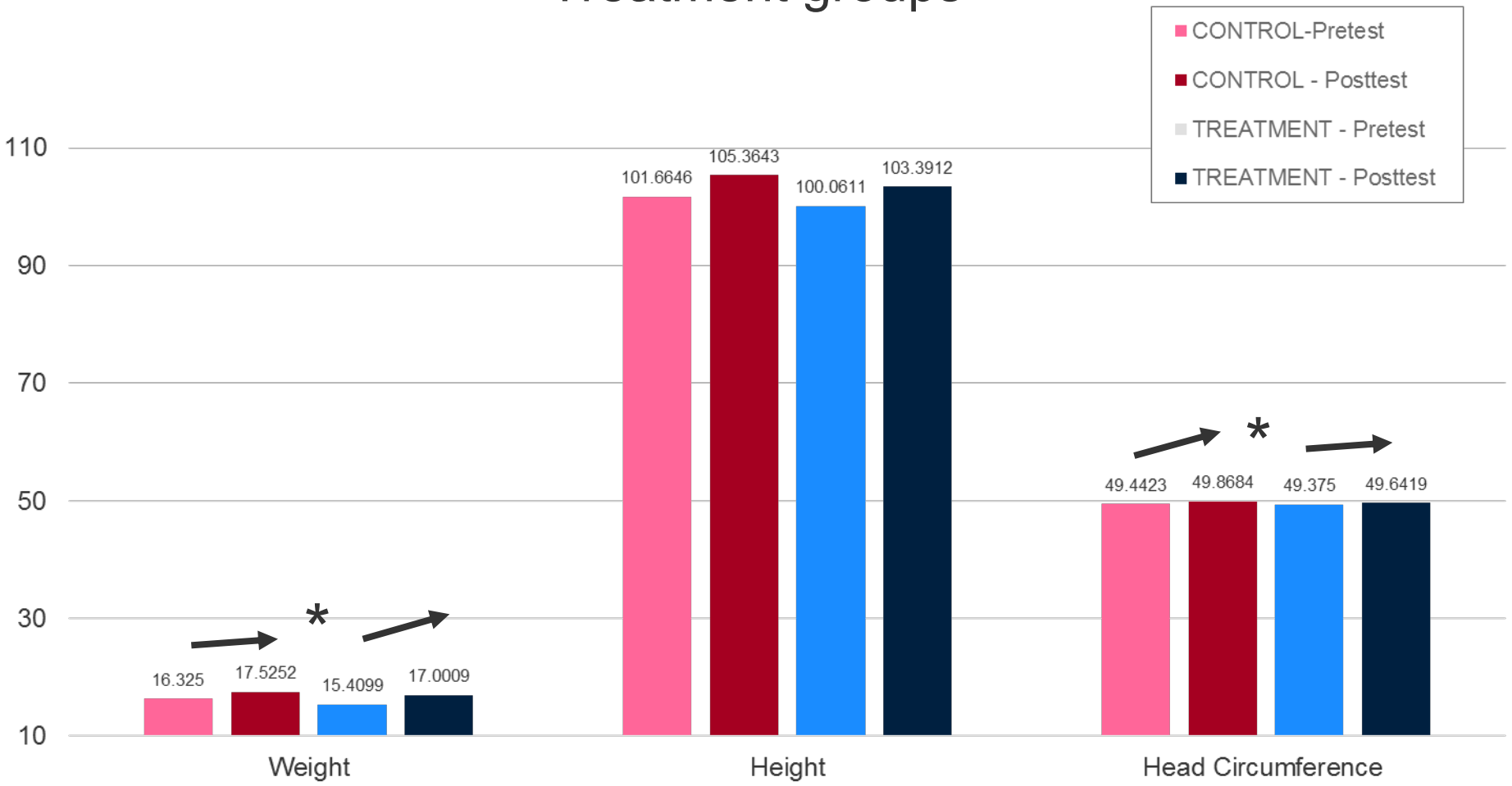
Comparison of PRE- and POSTTEST within Control & Treatment groups



There was also a significant increase in weight, height and HC among Tx group at the start and end of the study.

ANTHROPOMETRY

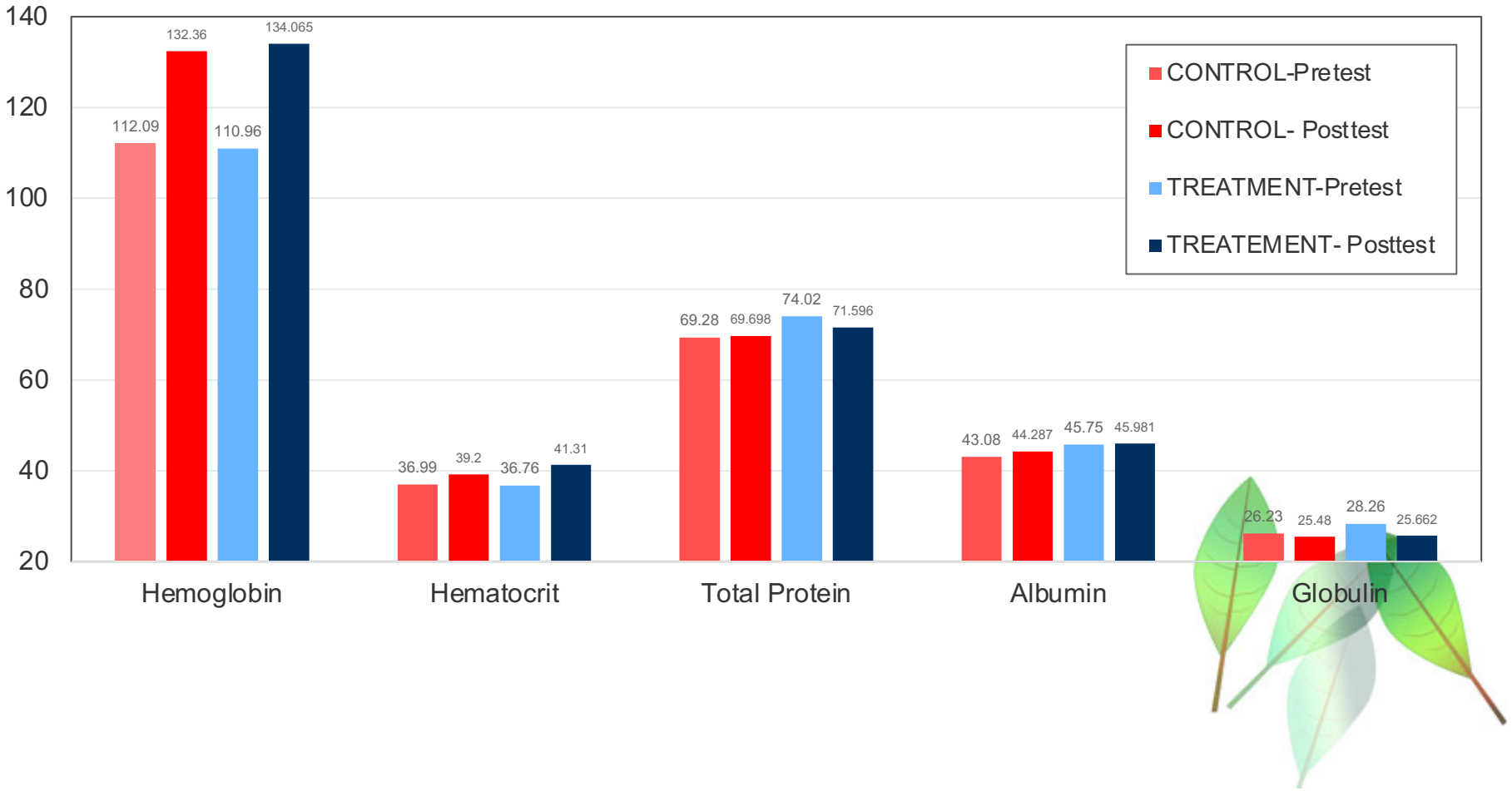
Comparison of MEAN CHANGE between Control & Treatment groups



The mean increase in weight was significantly higher among Tx group

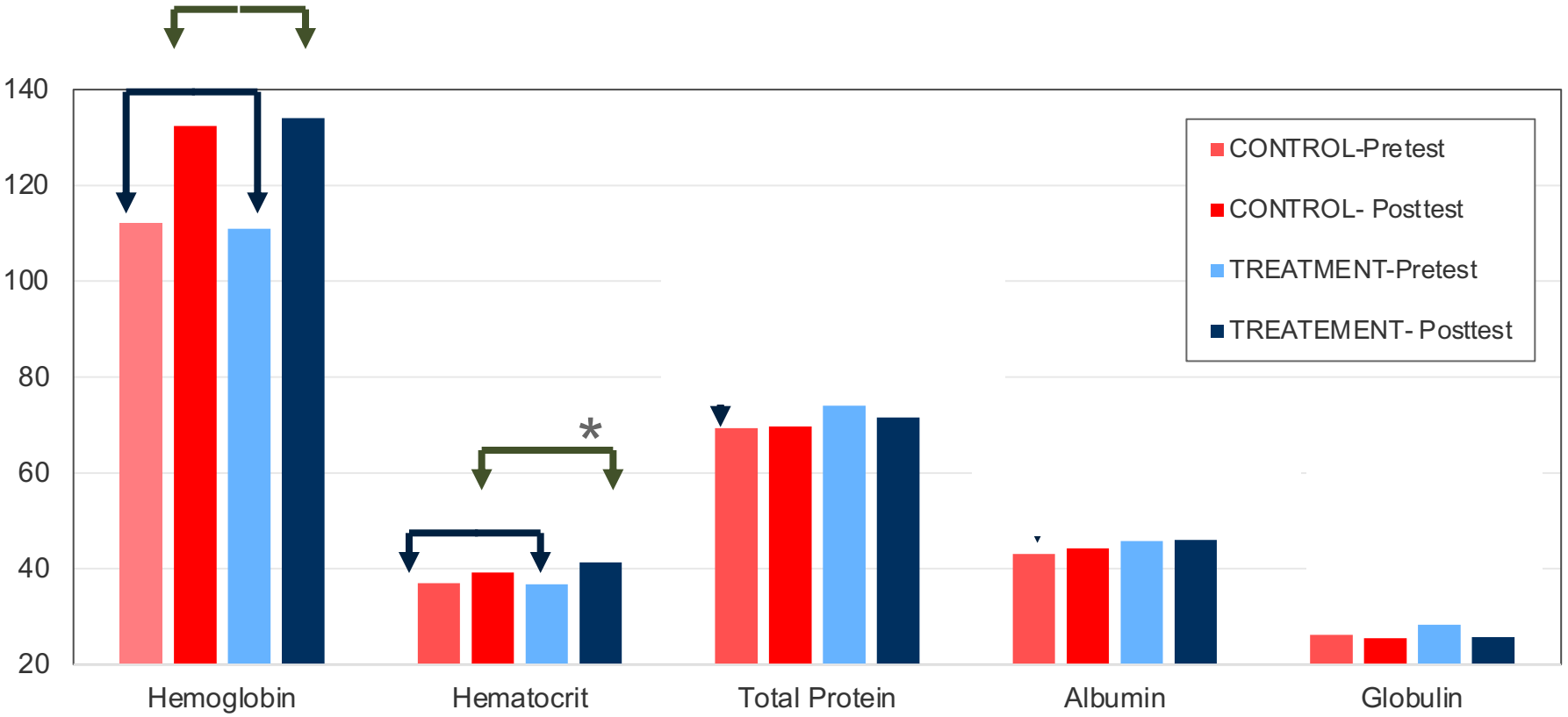
LABORATORY RESULTS

Comparison between CONTROL & TREATMENT groups



LABORATORY RESULTS

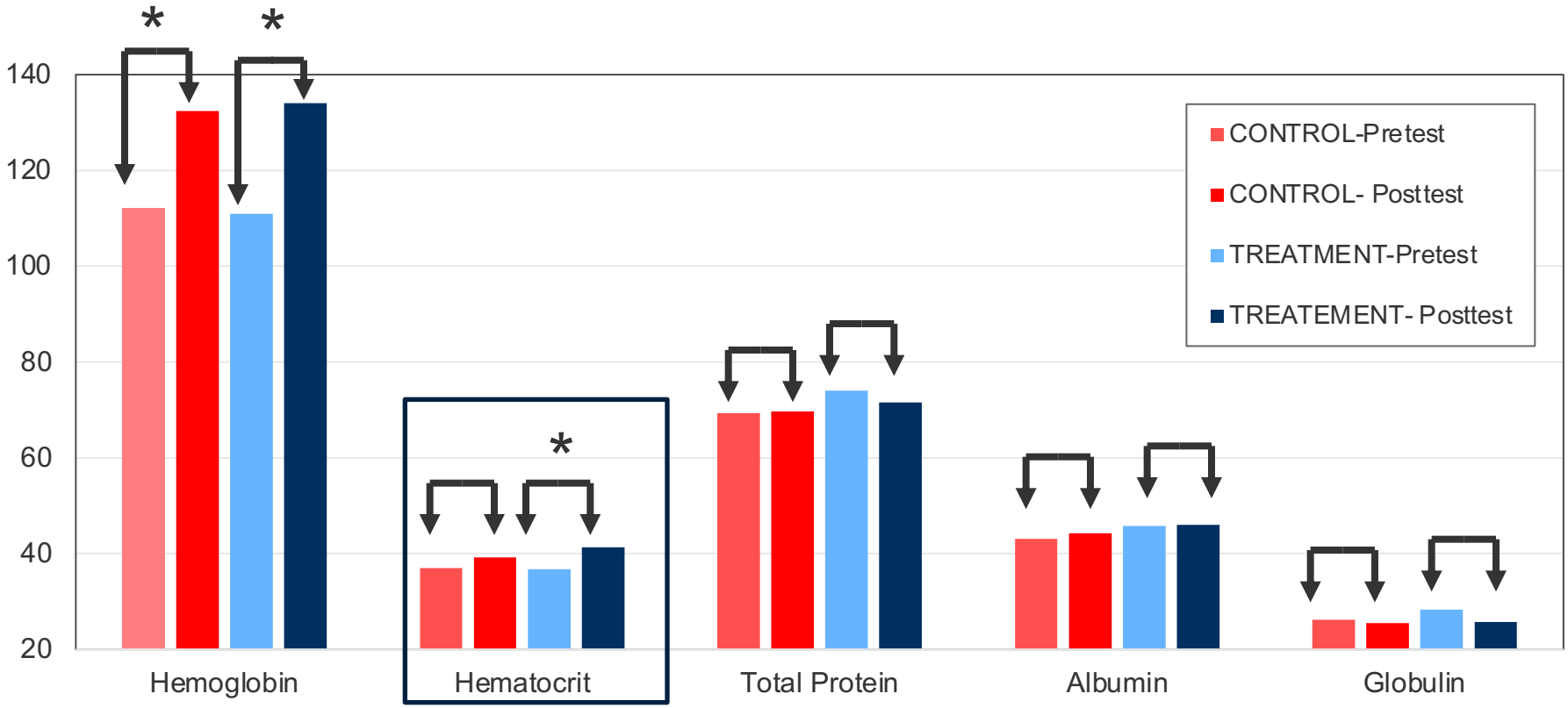
Comparison of POSTTEST VALUES between CONTROL & TREATMENT groups



At the start of the study, there was no difference in H/H but at the end of the study, the TX group has a significantly higher Hct (2 pts). Tx group has higher levels in TPAG at the start and end of study.

LABORATORY RESULTS

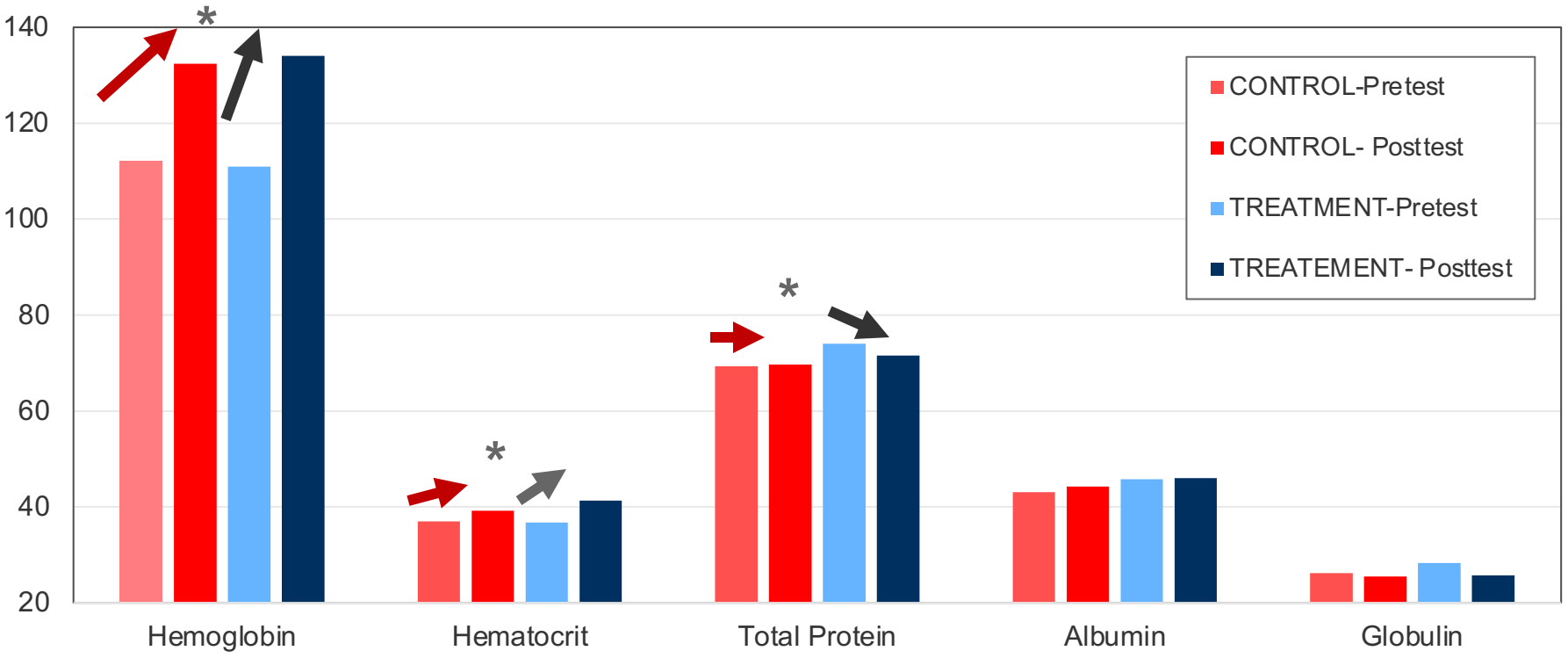
Comparison of PRETEST & POSTTEST within CONTROL & TREATMENT groups



Comparing pre and post study values within groups, the TX group has a significantly higher Hct at the end of the study.

LABORATORY RESULTS

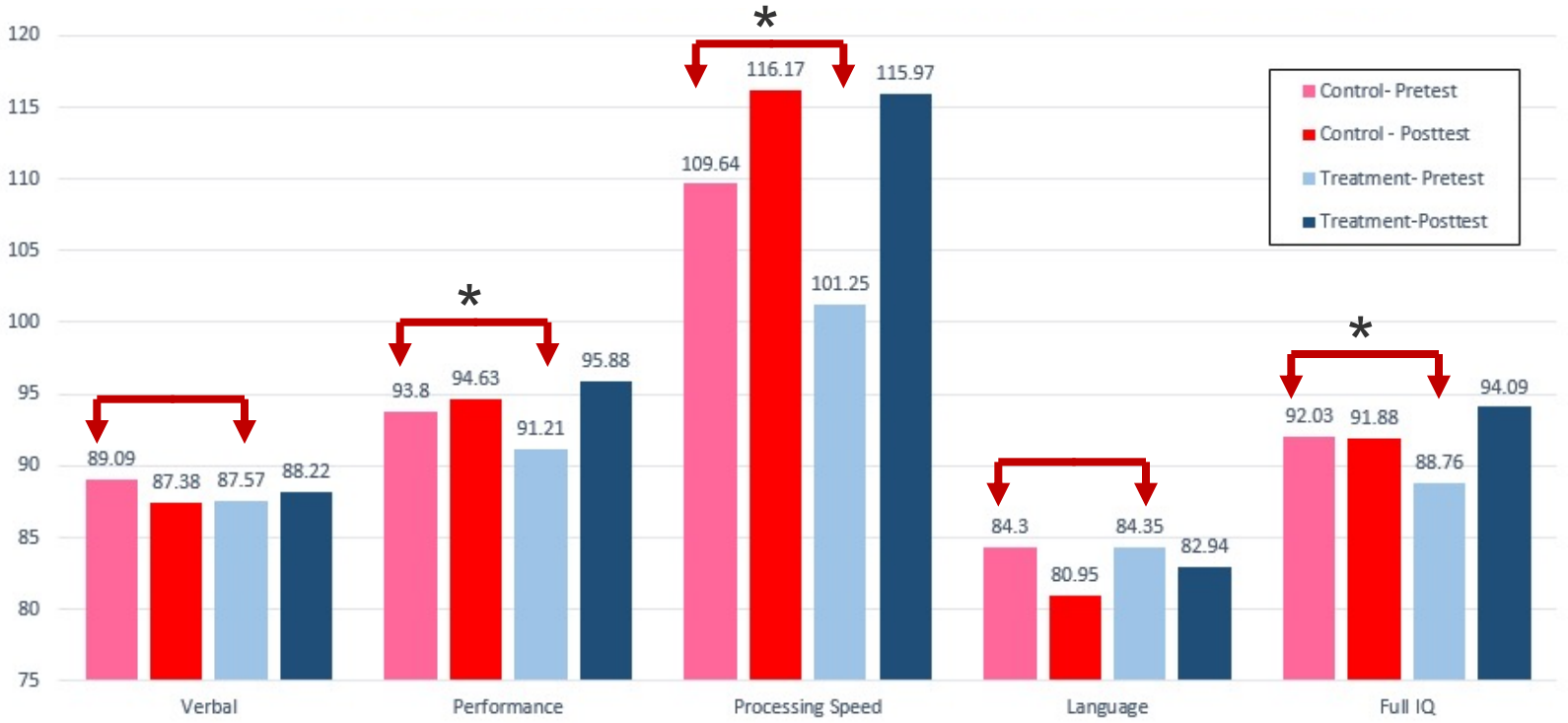
Comparison of MEAN CHANGE between CONTROL & TREATMENT groups



With regards mean change, there was a significantly higher mean increase in H/Hct in the TX group.

COMPOSITE IQ SCORES (WPPSI-III)

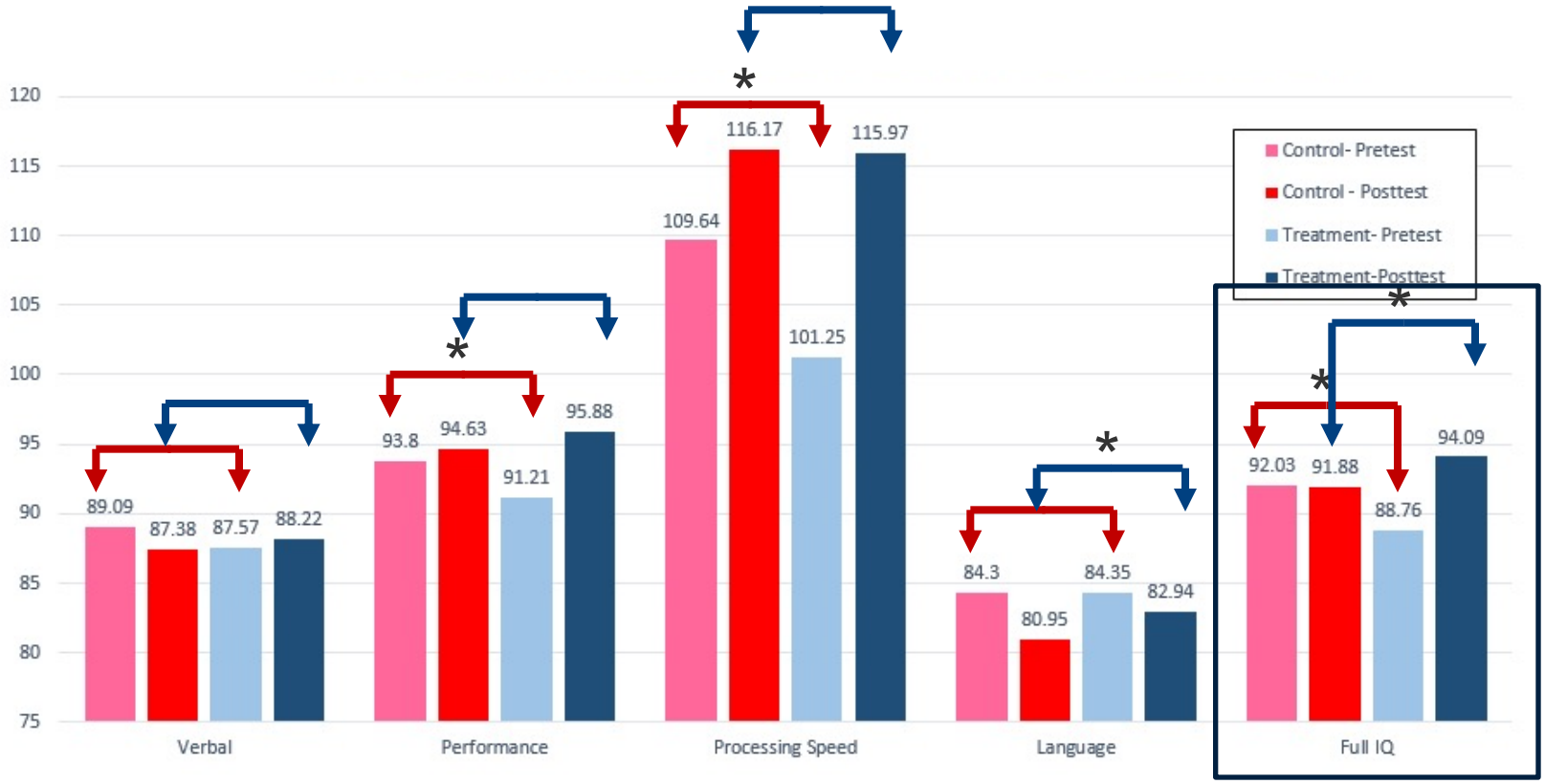
Comparison of PRETEST VALUES between the CONTROL & TREATMENT GROUP



At the start of the study, the control group has a significantly higher composite scores for performance and processing speed as well as the full IQ score (92.03 vs 88.76).

COMPOSITE IQ SCORES (WPPSI-III)

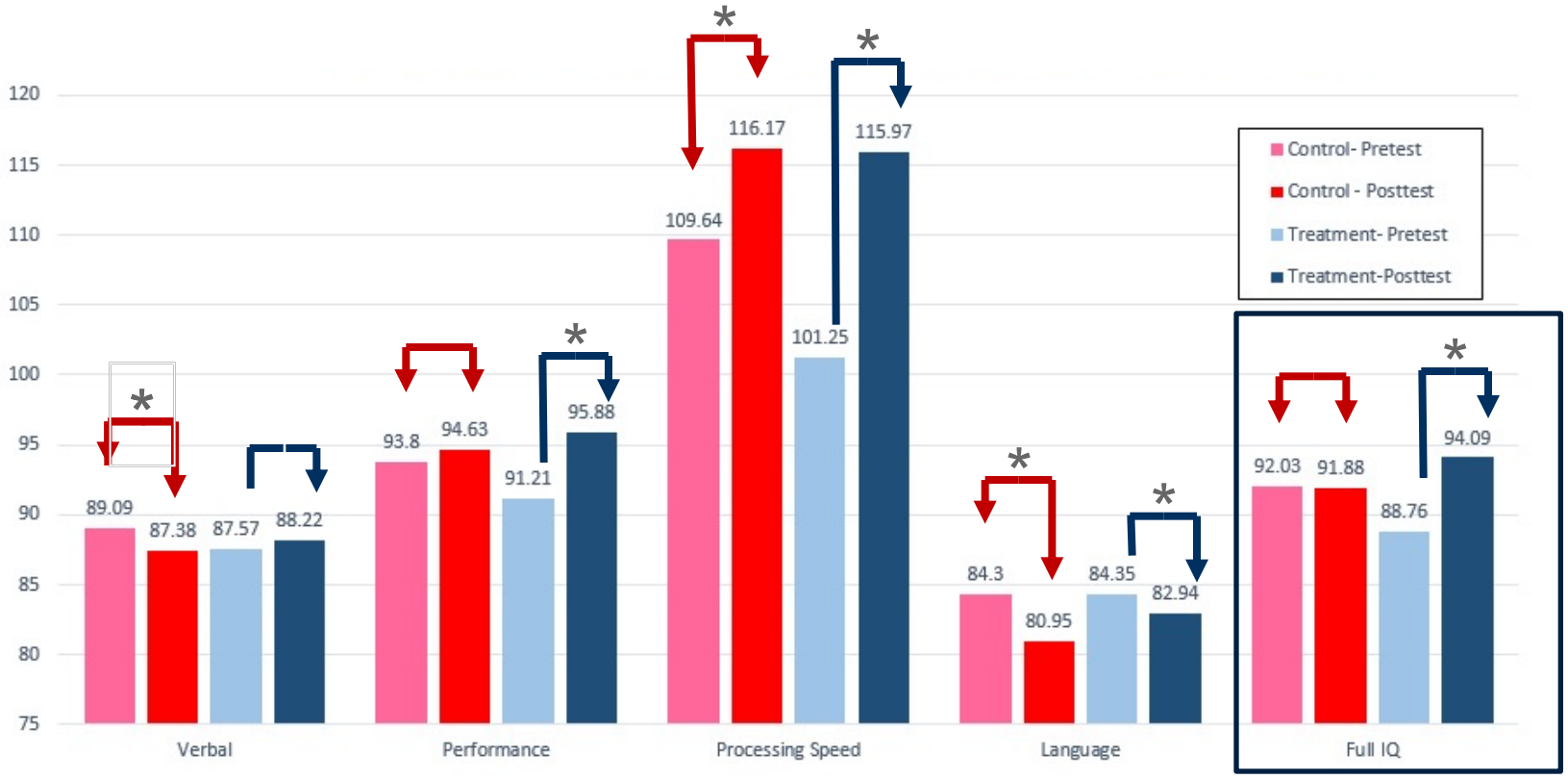
Comparison of POSTTEST VALUES between the CONTROL & TREATMENT GROUP



At the end of the study, there were no significantly difference in the verbal, performance and processing speed composite scores but a significantly higher language and full IQ scores (91.88 vs 94.09) in the treatment group compared with the control group.

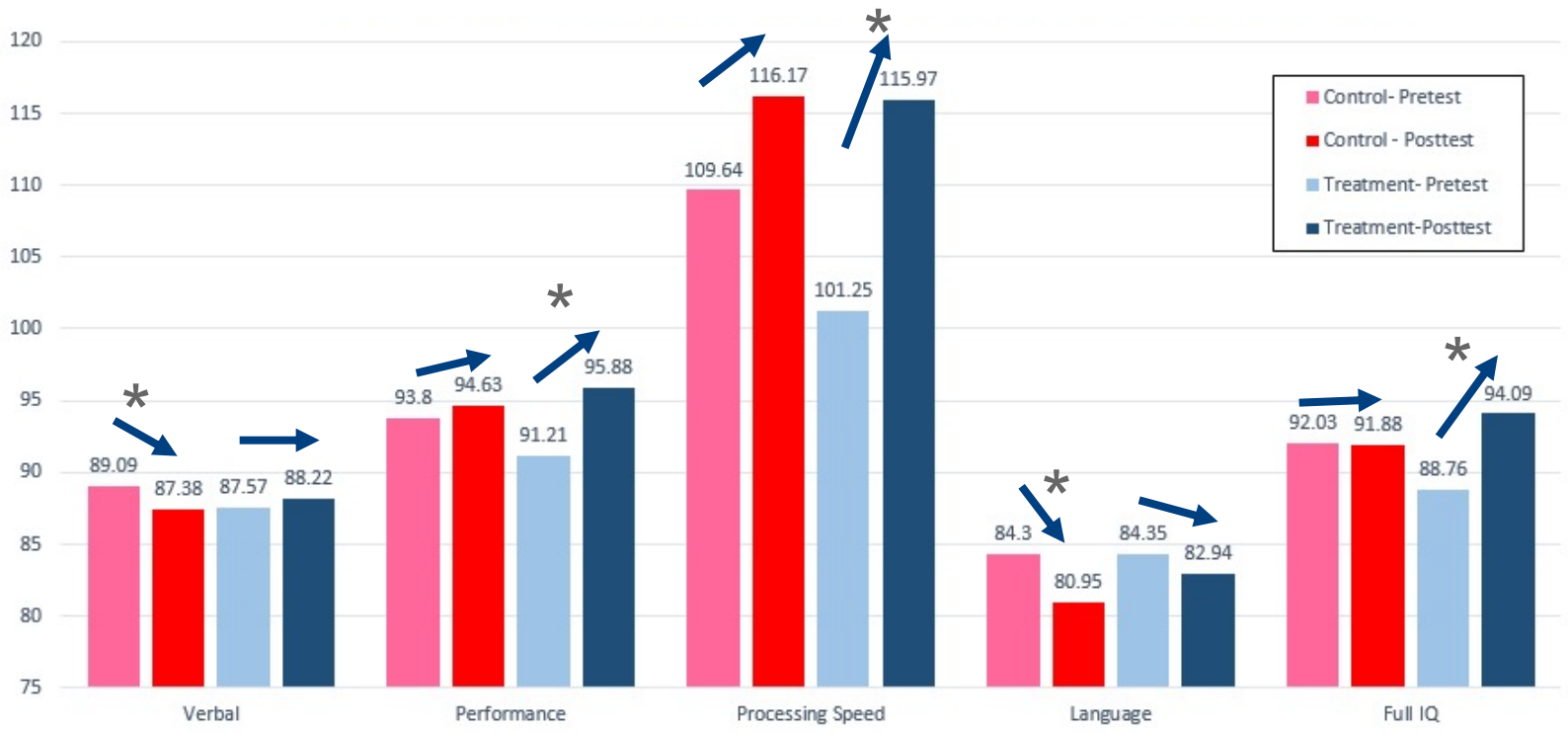
COMPOSITE SCORES (WPPSI-III)

Comparison of PRE- & POST-TEST within the CONTROL & TREATMENT groups



- Comparing pre and post study values, only the processing speed significantly Increased in the control group. TX group has a significant increase in performance, processing speed and full IQ (88.76 to 94.08)
- Reduction in scores in Language in both group may mean no change in raw scores but was divided by higher denominator – age).

COMPOSITE SCORES (WPPSI-IV)
Comparison of Mean Change between CONTROL & TREATMENT



- Comparing the mean changes between the TX and control group, there was a significantly higher mean increase in the performance, processing and Full IQ scores in the TX group.
- The mean reduction of scores in the Verbal and Language scores were significantly larger in the Control group.

Adverse effects

- Snacks were all consumed
- No reported food intolerance or diarrhea during the study period

Summary of Results

- At baseline, the control group were significantly
  - Older (4.2 vs 3.9 years old)
  - Heavier (16.3 vs 15.4 kg)
  - Taller (101.7 vs 101 cm)
  - Lower Blood lead levels (1.84 vs 7.57)

- Anthropometric measurements:
  - Control group still taller than treatment group
  - Anthropometric measurements at end of the study were significantly higher from baseline in both groups
  - Rate of rise of weight significantly higher among treatment group compared to control group

Summary of Results

- Laboratory Results:
  - No difference Hb/Hct and TPAG between the 2 groups at the start of the study
  - At the end of the study:
    - HB/HCT significantly higher among the treatment group
    - TPAG levels higher in treatment group

Summary of Results

Baseline IQ scores

- No significant difference between the 2 groups
  - Verbal
  - Language

- Control group significantly higher
  - Performance
  - Processing speed
  - Full IQ

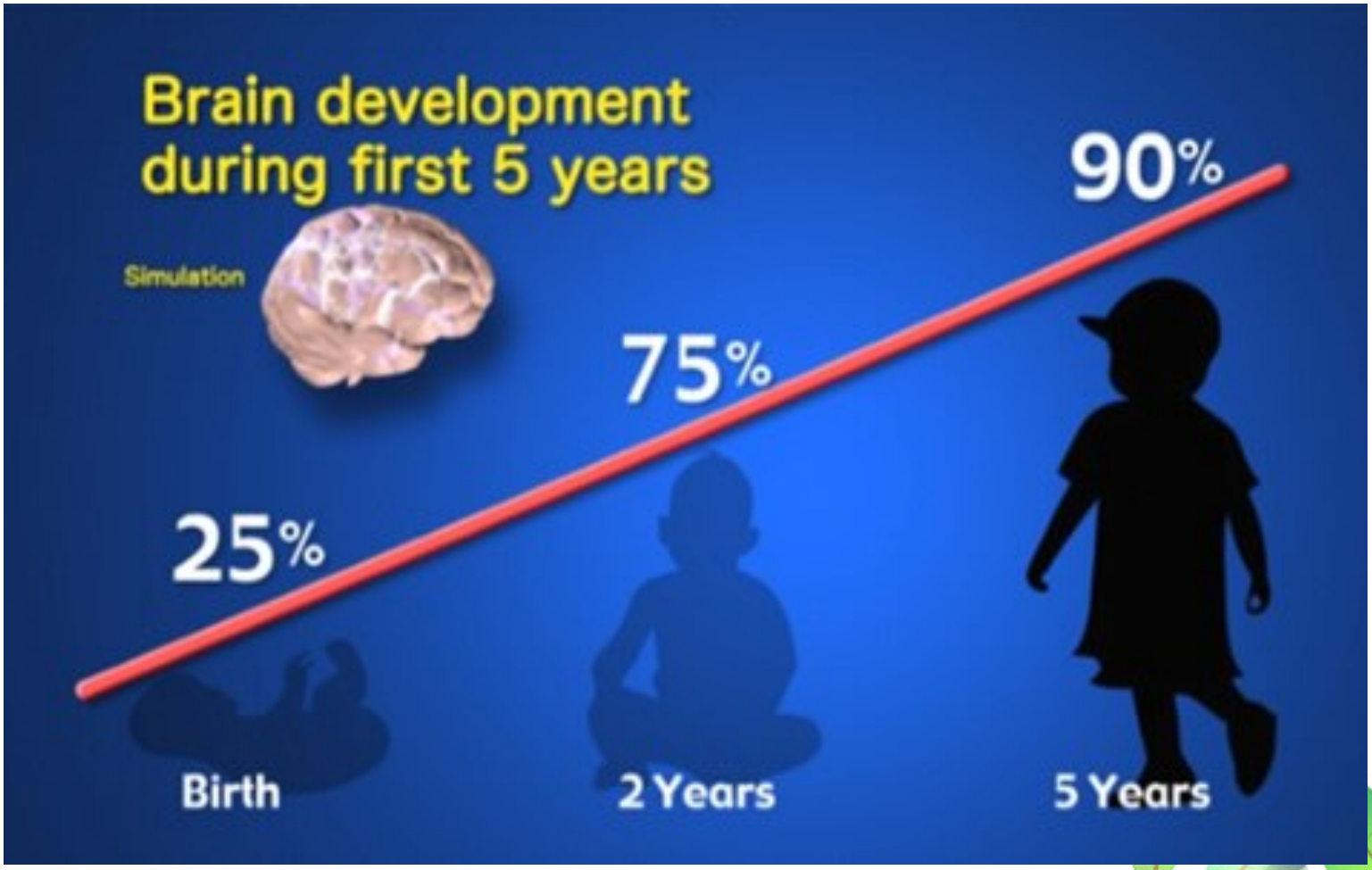
At the end of the study

- No significant differences between the 2 groups
  - Verbal
  - Performance
  - Processing Speed

- Treatment group significantly higher
  - Language
  - Full IQ (5.33 points increase)

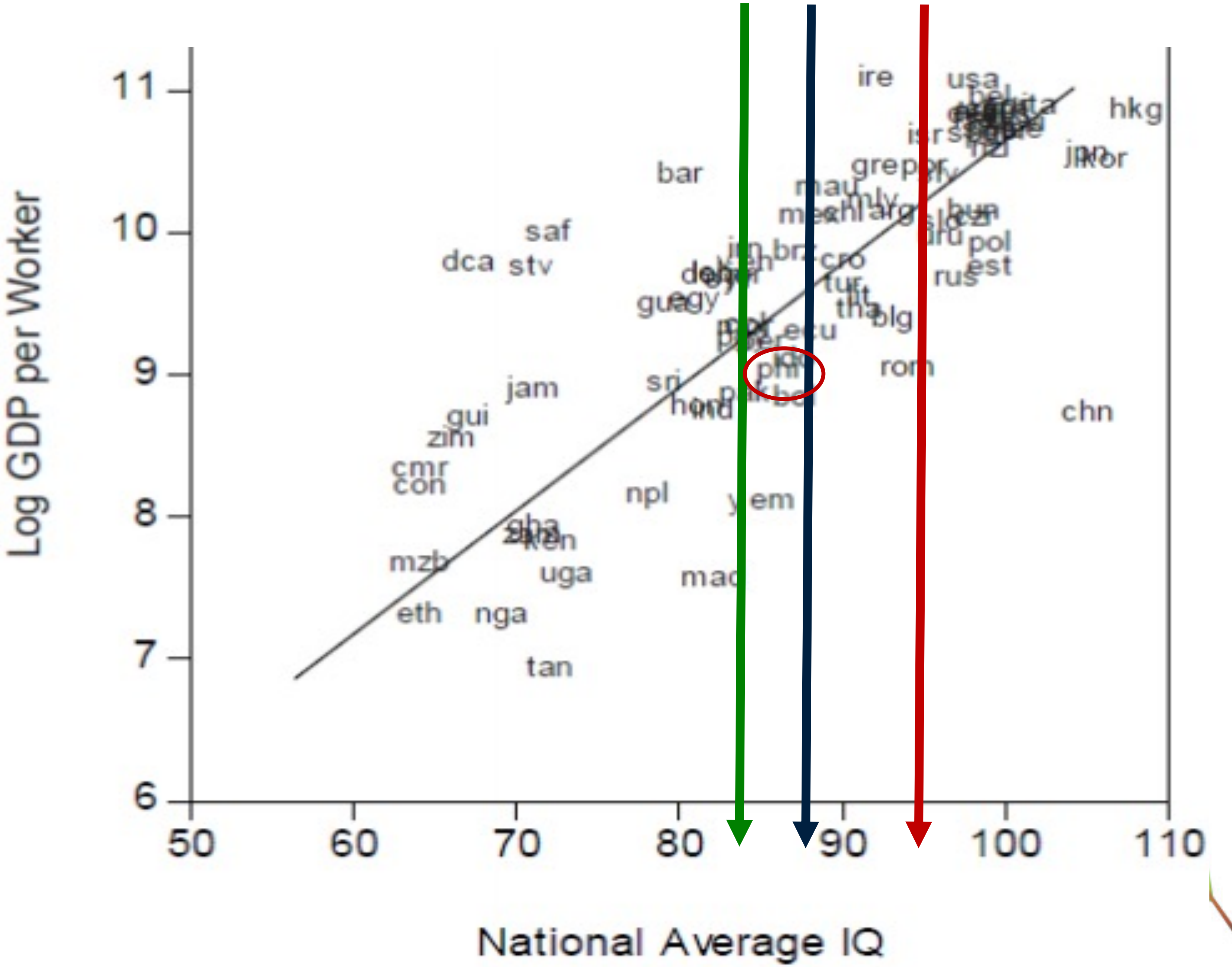
Discussion

- After 10 month enriched snacks,
  - There were already significant improvement in the treatment group
    - Weight
    - Hemoglobin
    - IQ


Brain development
during first 5 years
Simulation
25%
75%
90%
Birth
2 Years
5 Years

Discussion

- Economic analyses in the US suggest:
  - Increasing the IQ by 1 point -increases lifetime earnings by 1·8–2·4%.
- A recent modelling exercise in the UK postulated that a 2-point difference in IQ would increase lifetime earnings by between £35 000 and £72 000.


Log GDP per Worker
National Average IQ
11
10
9
8
7
6
50
60
70
80
90
100
110
ire
usa
hkg
isr
jpn
kor
bar
grep
mau
saf
dca
stv
hun
pol
est
rus
cro
tur
tha
blg
gue
egy
ecu
rom
jam
sri
hon
ind
chn
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eth
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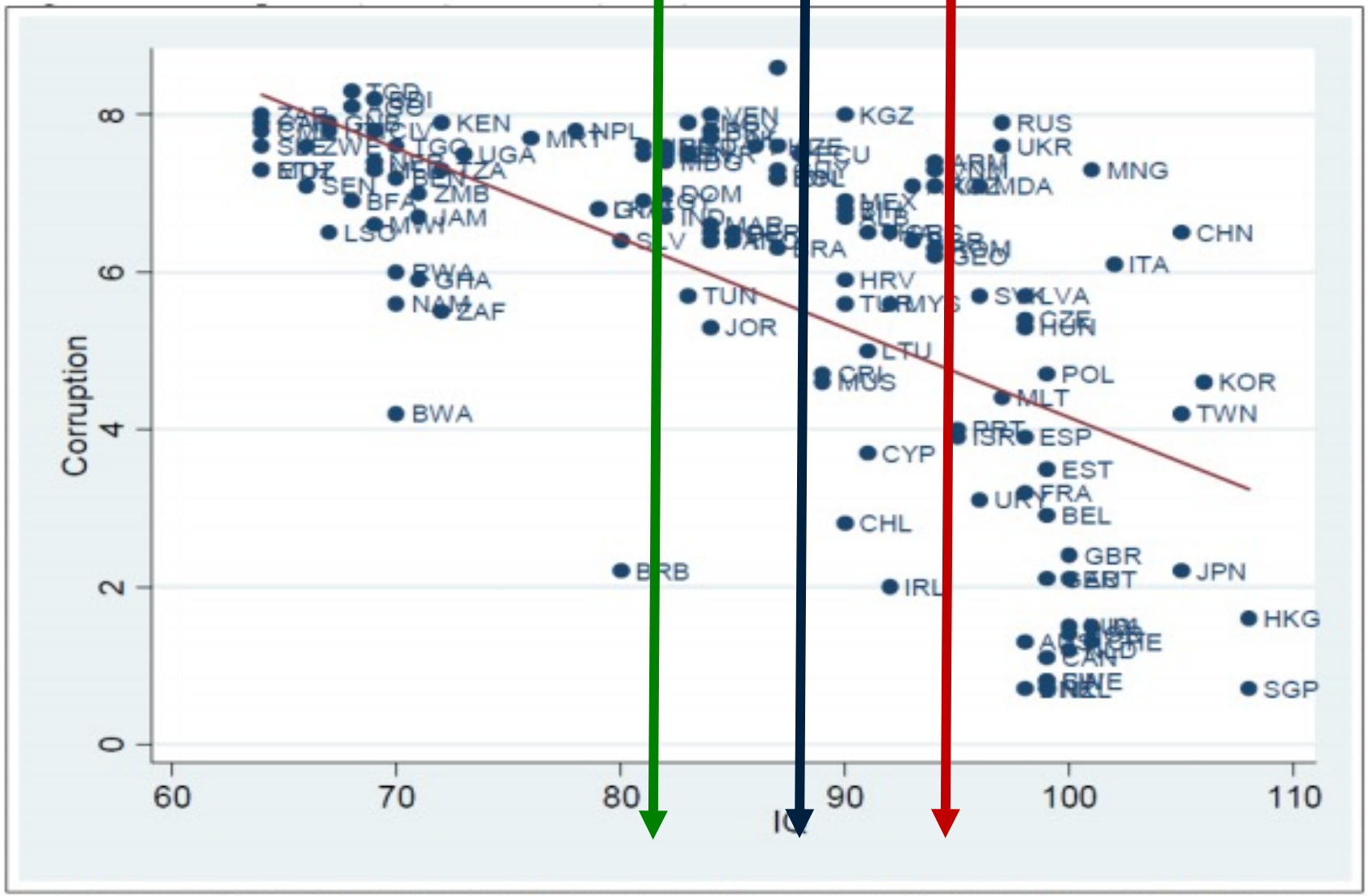
Figure 2: National IQ and Corruption



Correlation coefficient: -0.63. Source: Transparency International (2010) and Lynn and Vanhanen (2006)

Source: Potrafke (forthcoming).

Nutrition is only one of the variables affecting IQ

- Early feeding- breastfeeding
- Socio-economic status
- Maternal IQ
- Parental educational attainment
- Nurturing environment
- Environmental toxins
- Etc.

Conclusion

- Enrichment of snacks with iron (*Moringa*) and protein among daycare center children led to:
  - Significant increase in IQ (5.3286 vs -0.012)
  - Significant increase in weight (1.59 vs 1.18kg)
  - Significant increase in Hct (0.046 vs 0.022)