Research
a dietetic practice group of the
Academy of Nutrition and Dietetics

TheDigest

Volume 50, Number 3 – Summer 2015

Assessing Body Fatness in Obese Adolescents: Alternative Methods to Dual-Energy X-Ray Absorptiometry

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INTRODUCTION

Dual-energy X-ray absorptiometry (DXA) is a gold standard method for body composition measurement. It is a reliable and valid measure for clinical assessment of percent total body fat (%BF) in adult and pediatric populations.[1] Due to the high cost and labor of DXA, alternative methods for accurately measuring body composition are needed.[2] Measures including neck circumference (NC), thigh circumference (TC), body adiposity index (BAI) and bioelectrical impedance analysis (impedance) have been examined for the assessment of anthropometrics and body composition; however studies comparing these measurements to DXA in overweight and obese pediatric populations are limited.

As a basic anthropometric measure, NC is easy to implement in clinical practice. This measure is easily performed and is typically unaffected by clothing, respiratory movements, or satiety.[3,4] NC in children was found to be positively correlated with waist circumference, body mass index (BMI), height, and weight.[3,5-7] Studies in lean and overweight/obese pediatric populations have concluded that males have a greater NC when compared to females, which is also true of waist circumference and BMI across genders.[6,7] To date, no studies compare NC to %BF in children as assessed by DXA. Additional research is needed to assess the feasibility and reliability of NC in pediatric populations as a predictor of obesity and body fat distribution when compared against the gold standard.

TC is a noninvasive and simple measure that has been evaluated in the prediction of body fatness and disease risk.[8] Recent studies have suggested that TC reflects body muscle mass as well as peripheral subcutaneous fat in adult populations.[9] A study of Danish men and women found that a low TC was associated with an increased risk of developing heart disease or premature death.[10] Researchers in another study looking at white men and women concluded that a larger TC was associated with a lower risk of

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type 2 diabetes, although they noted that a protective effect was statistically significant only in women.[11] While the mechanism is not yet known, one study proposed that this gender difference may be due to regional differences in adipocyte metabolism which is more pronounced in women than in men.[12] A study using magnetic resonance imaging (MRI) to measure body fat in white men and women concluded that when controlling for waist circumference, TC was positively correlated with total and abdominal subcutaneous adipose tissue and skeletal muscle but negatively associated with visceral adipose tissue.[13] The researchers hypothesized that the protective effect of a larger TC is due to the increased deposition of lower-body and abdominal subcutaneous adipose tissue and skeletal muscle, a decreased accumulation of visceral adipose tissue, or both.[13] While researchers have investigated the use of TC as a predictor of body fat distribution and disease risk in the adult population, studies specifically looking at this measurement as a useful alternative to DXA %BF in pediatric populations are warranted.

The BAI equation, which is a ratio of hip circumference to height, was developed in 2001 using a population of adult Mexican Americans ranging in BMI from underweight to morbidly obese.[14] The equation was compared against DXA %BF and validated in a population of adult African Americans with BMIs ranging from normal weight to morbidly obese.[14] Very few studies have assessed BAI in pediatric populations; however, it has been shown to overestimate male adiposity and underestimate female adiposity in adolescent populations.[15] In white children (5-12 years), BAI was not predictive of %BF as measured by Impedance.[16] In this younger population of children, a pediatric BAI (BAIp) was developed. However, BAIp was noted to be less useful on an individual scale for predicting %BF than on an epidemiologic scale. Further research is necessary to assess the use of BAIp in pediatric populations. Impedance analysis is a common method utilized in research and clinical settings to analyze a subject's body composition. The premise of this measure relies on the implication that fat free mass (FFM), due to its greater electrolyte content, is a better conductor of electrical current than fat mass.[17] Impedance is a useful method for assessing body fatness because it is non-invasive and is associated with marginal cost and reasonable accuracy.[18,19] There are multiple equations that have been developed for use with Impedance; however, much of the initial research surrounding the development of these equations focused on lean adults. Deurenberg and colleagues and Schaefer and colleagues developed Impedance equations to estimate fat free mass in pediatric populations.[20,21] Later, Cleary and colleagues validated both equations against DXA in a sample of overweight and obese children aged 5-9 years. The %BF as determined by the Schaefer equation was the only result that did not significantly differ from DXA in this population.[22] Additional research is needed to evaluate the validity of Impedance equations in obese adolescents.

Pediatric studies assessing the validity of NC, TC, BAI, and Impedance compared to DXA have been limited. The aim of this study was to investigate more clinically feasible indices to assess body fatness in overweight and obese adolescents at risk for associated comorbidities.

METHODS

Sample population:
This cross-sectional study examined baseline data from a randomized clinical trial conducted at the National Institutes of Health (NIH) Clinical Center (clinicaltrials.gov identifier NCT00001723). The original trial was approved by the NIH National Institute of Child Health and Human Development Review Board, and informed consent and assent were obtained from all subjects and their parents prior to study initiation. Subjects were male and female adolescents aged 12-17 years and weighing at least 60 kg. BMI-for-age was >95th percentile using National Health and Nutrition Examination Survey I criteria.[23] Subjects also had at least one quantifiable, obesity-related comorbidity as determined during the screening admission. Subject race was self-identified as either non-Hispanic white or African American with all four grandparents also self-identified as all white or all African American. The original sample size for this study was 174 subjects. Five subjects were

Table 1. Mean and standard deviation (SD) for age and anthropometric measures of sample population

	Mean (SD)
Age (y)	14.4 (1.4)
BMI (kg/m^2)	38.3 (5.9)
Neck circumference (cm)	38.8 (3.2)
Thigh circumference (cm)	69.7 (7.5)
Body fat from BAI (%)	39.5 (6.2)
Body fat from BAI_p (%)	43.3 (7.5)
Body fat from $Impedance_D$ (%)	62.5 (4.5)
Body fat from $Impedance_S$ (%)	56.9 (5.2)
Body fat from DXA (%)	46.8 (4.7)

excluded due to missing data for a final sample size of 169.

Measures of body composition:
Height, weight, hip circumference, NC, and TC were collected at the baseline outpatient study visit. Standing height was measured in duplicate to the nearest tenth of a cm using a wall stadiometer with a fixed vertical backboard and an adjustable headpiece. Weight was measured in kg on a digital scale while subjects wore minimal clothing without shoes. All circumference measures were completed in duplicate to the nearest tenth of a cm using a stretch-less tape measure. NC was measured just inferior to the laryngeal prominence at the minimal circumference with the tape measure positioned perpendicular to the long axis of the neck.[24] Hip circumference was measured at the maximal protuberance of the buttocks in the horizontal plane with the subject standing erect with feet together and weight distributed evenly across both feet.[23] TC was measured at the midpoint of the right thigh (between the inguinal crease and the cephalid border of the patella) with the subject standing with right leg forward and weight placed on left leg.[23,24] All measurements were performed in the fasted state in the morning by one of two registered dietitians certified in body composition measurement in order to reduce measurement variability.

Percent BF was calculated from height and hip circumference measurements using the BAI equation previously developed in adults[14] as well as the equation developed specifically for use in pediatrics (BAIp):[16]

$$BAI = \frac{Hip\ circumference\ (cm)}{Height\ (m)^{1.5}} - 18$$

$$BAI_p = \frac{Hip\ circumference\ (cm)}{Height\ (m)^{0.8}} - 38$$

Impedance measurement was taken post-void with the subject laying supine on a non-conductive surface. The subject's right shoe and sock and any jewelry on the right wrist or ankle were removed. The subject was positioned with arms away from the body and legs apart. Electrodes were placed on the wrist, finger, ankle, and toe on the right side of the body per instrument manufacturer instructions[25] and impedance was measured using a RJL Quantum II (RJL Systems, Clinton Township, MI) impedance analyzer. Fat free mass was then calculated using two previously validated equations by Schaefer et al ($Impedance_S$) and by Deurenberg et al ($Impedance_D$):[20,21]

$$\text{Impedance}_S = Fat\ free\ mass\ (kg) = 0.65 \times \frac{Height\ (cm)^2}{impedance} + 0.68 \times Age\ (yrs) + 0.15$$

$$\text{Impedance}_D = Fat\ free\ mass\ (kg) = 0.64 \times \frac{Height\ (cm)^2}{impedance} + 4.83$$

Fat free mass was then converted into %BF for comparison with DXA using the equation %BF = [(weight (kg) – FFM)/ weight (kg)] x 100.

On the same day that anthropometric measurements were taken by the dietitian, subjects underwent a DXA scan in hospital radiology. Body composition was measured using a Hologic QDR-4500A (Hologic Inc., Bedford, MA).

Statistical analyses:
Descriptive statistics were expressed as percentages for categorical variables, and mean and standard deviation for continuous variables (IBM SPSS Statistics for Windows, Version 21.0, Armonk, NY). NC and TC were converted to z-scores using applicable reference standards.[26,27] Pearson correlations were used to compare the various body composition measurements to DXA %BF, and linear regression analyses were done to further compare NC and TC z-scores with DXA %BF. Since z-scores, which take into account age and sex, were used in the regression models, the only other variable that was included with the z-scores was race. Bland-Altman and regression analyses were used to assess agreement for BAI, BAIp, $Impedance_D$ and $Impedance_S$, the measures most highly correlated with DXA (Graphpad Prism, version 6.0, La Jolla, CA).

RESULTS

Mean age of the study participants (n=169) was 14.4 ± 1.4 years and mean BMI was 38.3 ± 5.9 kg/m2 (Table 1). The majority of the subjects were female (68%) and greater than half were African-American (57%).

No association was observed between NC z-score and DXA %BF in the sample

Table 2. Associations between body composition measures and DXA %BF (*p<0.001)

	All Subjects (n=169)	African American (n=97)	White (n=72)	Female (n=115)	Male (n=54)
NC z-score	-0.049	-0.162	0.079	-0.038	-0.065
TC z-score	-0.413*	-0.418*	-0.495*	-0.513*	-0.264
BAI	0.578*	0.519*	0.712*	0.625*	0.504*
BAI_p	0.580*	0.539*	0.684*	0.644*	0.458*
$Impedance_D$	0.655*	0.685*	0.648*	0.671*	0.630*
$Impedance_S$	0.634*	0.678*	0.614*	0.635*	0.658*

Table 3. Regression models examining the relationships between neck and thigh circumference z-scores and DXA %BF

	R^2	β	p-value
Model 1			
NC z-score	0.002	-0.160	0.518
Race	0.003	0.168	0.822
Model 2			
TC z-score	0.170	-1.942	0.000
Race	0.203	1.854	0.010

(Table 2) and NC z-score was not predictive of DXA %BF when assessed using multiple regression analysis (Table 3). TC z-score was predictive of DXA %BF (Table 3) in regression analyses and was moderately associated with DXA %BF in correlation analyses for females (Table 2).

BAI and BAIp were positively correlated with DXA %BF across all subjects (r=0.578 and r=0.580 respectively, p<0.001) (Table 2). Percent BF calculated from $Impedance_D$ and $Impedance_S$ equations was also positively correlated with DXA %BF for all subjects (r=0.655, p<0.001 and r=0.634, p<0.0001 respectively) (Table 2). Bland-Altman analyses of %BF derived from BAI, BAIp, $Impedance_D$ and $Impedance_S$ compared to DXA %BF are shown in Figures 1 and 2. BAI underestimated %BF by 7.3% ± 5.2% as compared to DXA; however, a significant magnitude bias was present (r^2=0.097, p<0.001) (Figure 1A). BAIp underestimated %BF by -3.5 ± 6.1% with significant magnitude bias (r^2=0.250, p<0.001) (Figure 1B). $Impedance_D$ and $Impedance_S$ both overestimated %BF (15.7 ± 3.8% and 10.2 ± 4.2%, respectively); however, no magnitude bias was detected for Impedance measurements (r^2=0.006, p=0.319 and r^2=0.012, p=0.163 respectively) (Figures 2A and 2B).

DISCUSSION

The purpose of this study was to identify a simpler, less expensive measure than DXA for assessing body fatness in overweight and obese adolescents. An alternative measure to DXA is needed in this population because measurement with DXA is expensive, immovable, and delivers a small dose of radiation. The alternative measurements examined in this study were less labor-intensive and more cost-effective as equipment such as stadiometers, scales, tape measures and impedance analyzers were used.

As a non-invasive anthropometric measure, NC has been identified as a possible alternative to DXA as it has been shown to be well correlated with BMI and chronic disease in pediatrics.[3,5-7] However, the present study found no correlation between NC z-score and DXA %BF. This may be due to the exclusion of individuals with an underweight or normal BMI. In our obese pediatric population, the range

Figure 1. Bland-Altman graphs of BAI (A) and BAIp (B) vs. DXA

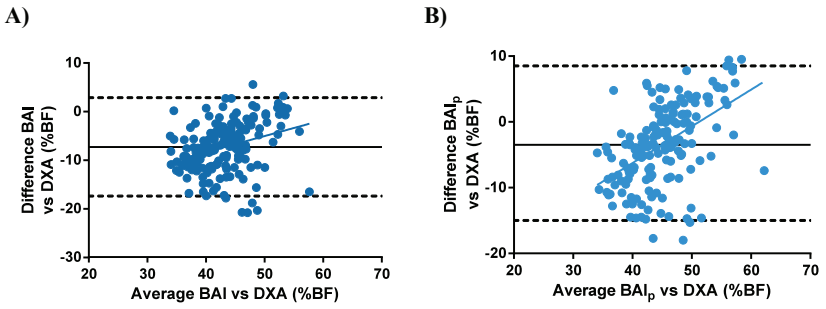
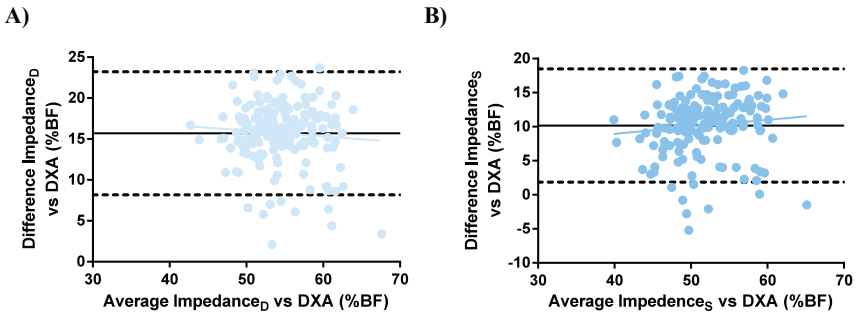


Figure 2. Bland-Altman graphs of ImpedanceD (A) and ImpedanceS (B) vs. DXA



of NC measures may not vary enough across subjects to show an association with DXA %BF. Also, the mean NC in the given population (38.8 cm) was greater than suggested cut-off values for elevated BMI identified in previous studies (27.4-31.3 cm in boys; 26.3-31.4 cm in girls).[6] It is possible that an equation using height and/or weight with NC would result in an association with DXA %BF; therefore, further investigation is warranted to develop such an equation. At this time, NC cannot be recommended as an alternative measure to DXA in obese adolescents.

Previous studies have investigated the use of TC as a practical measure to predict body fat distribution and disease risk in adults. This study was the first to examine TC z-score as a possible alternative to DXA in the prediction of %BF in pediatrics as previous research on this association has only been done in adults.[12,28] In our study, TC z-score was negatively associated with DXA %BF only in females and was predictive of %BF in regression equations when race was taken into account. Since TC needs to be adjusted for age, sex, and race when using it in research, this may not be as simple to use to estimate %BF as other measures being examined. Therefore, in contrast to others who have examined this measure in association with disease risk or in adult populations, we do not feel that this measurement should be recommended to use in place of DXA for prediction of %BF in obese adolescents without further exploration.

In this study, both BAI and BAIp were significantly correlated with DXA %BF. The BAI correlation is in line with results by Dias et al. in which BAI was significantly correlated with DXA %BF in Brazilian males and females aged [13-16] with BMIs classified as normal, overweight, or obese;[28] however, our study looked at white and African American adolescents of a broader age range (12-17 years). Additionally, Dias et al only looked at the BAI measure; the present study is the first study to date comparing pediatric measures of %BF from BAIp with %BF from DXA. In the current study, BAIp had better agreement with DXA %BF than did BAI; the difference between DXA and BAIp was -3.5 + 6.1%. However, BAI and BAIp both showed significant magnitude bias, indicating that both measures become increasingly less accurate compared to DXA as body fat increases. This agrees with results by Wickel, who found that agreement between %BF from skinfolds and from BAI showed magnitude bias for both genders of adolescents.[15] The bias observed in our study suggests that neither BAI nor BAIp is an accurate predictor of %BF for all ranges of %BF in this pediatric population. Therefore, BAI and BAIp are not recommended as alternatives to DXA for measuring pediatric body adiposity.

$Impedance_S$ and $Impedance_D$ were both positively correlated with DXA %BF for all subjects in this study. Both impedance measures systematically over-estimated %BF compared to DXA (15.7 + 3.8% for $Impedenace_D$ and 10.2 + 4.2% for $Impedance_S$). However, given the limited magnitude bias and easily correctible systematic over-estimation, our data suggests that $Impedance_S$ may be an easier and less expensive alternative to DXA in assessing body fatness in obese adolescents. Our results are consistent with those of Cleary et al who also demonstrated significant correlations between $Impedance_D$ and $Impedance_S$ when compared to DXA %BF in overweight and obese children aged 5-9 years.[22] While both equations over-estimated %BF compared to DXA, Cleary concluded that $Impedance_S$ provided the most accurate estimate of %BF due to limited bias. Future studies should evaluate this systematic overestimation to develop more accurate Impedance equations for obese pediatric participants.

A major strength of this study was the use of DXA, considered by many to be the gold standard measurement of body composition, as a comparison tool to identify a simpler, less costly measure of body fatness in an obese pediatric population. To date, there are a limited number of validation studies using DXA as a reference measure for body fatness in children; more common validation measures include skinfolds, waist circumference, and various methods of bioelectrical impedance analysis.[15,16,28] Lastly, in order to reduce variability, all of the measurements were performed by two dietitians certified biannually to perform these measurements.

Limitations of this study include over-representation of females and inclusion of only white and African

American races in the study population. However, findings suggest $Impedance_S$ could be a useful measurement, which should be examined further in larger samples including subjects of varying ethnicities. Additionally, this study sample only included obese adolescents. As such, generalizations to pediatric populations with a wider range in weight status are difficult. Finally, this study does not evaluate data trends over time when comparing different measurements. Therefore, it is not possible to make a conclusive validation of $Impedance_S$ as an alternative to DXA.

Given the pediatric obesity epidemic and its associated morbidities, more research is needed to develop an inexpensive, efficient, and accurate measure of body composition for clinical and research use. Of the measures reported in this study, $Impedance_S$ may be the simplest and most accurate predictor of %BF in obese adolescents when compared to DXA %BF. However, further validation studies are warranted to explore $Impedance_S$ as an alternative to DXA in pediatric populations.

Acknowledgements: This research was supported by the Intramural Research Program of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development ZIA-HD-00641 (to J. Yanovski) with supplemental funding from the National Institute on Minority Health and Health Disparities and the Division of Nutrition Research Coordination, NIH. Disclaimer: Dr. Yanovski is a Commissioned Officer in the U.S. Public Health Service. The opinions and assertions expressed herein are those of the authors and are not to be construed as reflecting the views of the U.S. Public Health Service.

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Research DPG: Question and Answer

Assessing Body Fatness in Obese Adolescents: Alternative Methods to Dual-Energy X-Ray Absorptiometry

CPE Writer: Caroline Sullivan, MS, RD

1. What is considered the most reliable method of assessing body composition in both adult and pediatric populations?
   a. Bioelectrical impedance analysis
   b. Dual-energy X-ray absorptiometry
   c. Underwater weighing
   d. Three site triceps skin-fold

2. Thigh circumference is correlated with
   a. Abdominal adiposity
   b. Body mass index
   c. Waist circumference
   d. Body muscle mass

3. Body adiposity index is a ratio of
   a. Waist circumference to height
   b. Hip circumference to height
   c. Thigh circumference to total body weight
   d. Bicep circumference to total body weight

4. What criterion was used to identify appropriate subjects for this study?
   a. BMI higher than 95th percentile
   b. Age between 10 and 18
   c. Absence of comorbid conditions
   d. Total body weight higher than 50 kg

5. Which measurement was a significant predictor of DXA body fat percentage?
   a. Neck circumference
   b. Waist circumference
   c. Thigh circumference
   d. Bicep circumference

6. Why is it advantageous to utilize ¬¬impedance to measure body fatness?
   a. Accuracy
   b. Ease of use
   c. Reliability
   d. Ease of interpretation

7. The body adiposity index and pediatric body adiposity index both became less accurate as what increased?
   a. Body fat
   b. Lean muscle
   c. Waist circumference
   d. Total body water

8. Which method of assessing body fatness did the study find most useful as an alternative to DXA?
   a. Neck circumference
   b. Thigh circumference
   c. Body adiposity index
   d. Bioelectrical impedance

9. Which method of assessing body fat overestimated compared to DXA results?
   a. BAI
   b. BAIp
   c. Impedances
   d. BMI

10. What was a limitation of the present study?
   a. Large percentage male subjects
   b. Inclusion of only two races
   c. Usage of DXA for comparison
   d. Narrow range of subject age

The Chair's Message

Karin Pennington, MS, RD, LD
Chair, Research DPG
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Welcome to the beginning of the fiscal 'New Year' for The Academy and the Research DPG! We have a great year planned, and we welcome all new and returning members! It is because of you that the Executive Committee is able to continue to support and encourage research both within The Academy and within our professional practice. The Executive Committee team includes Alanna Moshfegh (Past Chair), Lauri Byerley (Chair Elect), Brook Harmon (Secretary), Beth Reverri (Treasurer), and Jennifer Hanson (Nominating Committee Chair). Other key members of the Executive Committee include Ginger Quick (Digest Editor), Jeanene Fogli (Awards Chair), Mara Vitolins (HOD Delegate), Mary-Jon Ludy (Public Policy Committee Chair and Nominating Committee), Nancy Emenaker (Nominating Committee), Elizabeth Parker (Website Committee Chair), Nicole Litwin (LinkedIn Chair), Courtney Tiemann Luecking (Visioning Process Representative), Rachel Paul (Student Representative), and Katie Gustafson (Academy Staff Manager).

As we prepared for this year, we wanted to keep the DPG progressing on longer term goals which include updating of the website and additional opportunities for member networking, education, and grants. A sincere 'Thank you' is extended to past Chairs, James Swain, Chris Taylor, Nancy Emenaker, and Alanna Moshfegh who have tirelessly orchestrated the ongoing work of this DPG!

To help meet our goals for you, we have several networking and education events scheduled for FNCE® 2015 in Nashville, TN. Mark your calendars! Details will be forthcoming.

- **Saturday, October 3:** Pre-FNCE Symposium. Research DPG member and position paper author, Kathryn Keim, will speak on non-nutritive sweeteners;
- **Monday, October 5:** RDPG member breakfast and awards presentation;
- **Monday, October 5:** Research DPG Showcase. Talk with your Executive Committee members to learn more about activities for our upcoming year and ways to get involved;
- **Tuesday, October 6 at 9:45am:** RDPG Educational Spotlight session. Research DPG member Catherine Champagne will speak on behavioral interventions to improve health in the session titled The "Weight" is Over: The Role of the Dietitian in Behavioral Approaches to Improve Health Outcomes.

I look forward to serving as your Chair for this year. The Executive Committee is always available to listen to your ideas on how to best serve you, our members. I look forward to meeting you at FNCE®!

Warm Regards,
Karin Pennington
Chair, 2015-16

My Thanks ...

As the Immediate Past Chair of the Research DPG, it seems like yesterday when my year as Chair began last June. In looking back, I believe the 2014-15 Executive Committee has accomplished several major goals: 1) securing a contractor to redesign and modernize the Research DPG web site which should be completed next year, 2) hosting a pre-conference workshop at FNCE 2014, 3) establishing a new award for Research DPG Member of the Year to be awarded yearly at FNCE, and 4) enhancing our sponsorship program to increase research funding opportunities for our members. I want to convey my thanks to all the Executive Committee members who gave their time and talents to enrich research in dietetics. It has been a privilege and a pleasure to serve with you. My thanks as well to all of our members for your participation and support of the Research DPG. I am looking forward to the 2015-16 term with Karin Pennington's leadership and determination as our Chair. The importance of research in dietetics practice is at the forefront. Continue to keep the Research DPG a part of your professional 'place.'

Alanna J. Moshfegh

Alanna Moshfegh, MS, RD
Immediate Past Chair, Research DPG

Notes from the Secretary's Desk…

Lauri O. Byerley, PhD, RDN, LDN

Hi Everyone! I have a new position on the RDPG executive board as Chair-Elect and have handed over the secretary pen to Brook Harmon, an Assistant Professor at the University of Memphis in Tennessee. Welcome Brook!

For my last "Notes from the Secretary's Desk…," I wanted to remind you all about the many avenues for networking, such as EML, LinkedIn and our website. If you have not joined the EML, consider doing so by sending an email to Inés Anchondo at Ines.Anchondo@ttuhsc.edu. Additionally, we will continue to keep you informed with upcoming events that are sent via monthly email blasts.

In April, an email blast was sent requesting RDPG members to complete two surveys on the HOD Mega Issues. Approximately thirteen percent of our members responded so thank you for those that participated! The results were noteworthy, and I know Mara Vitolins, our HOD delegate, appreciated those who responded and took their time to provide input and comments.

FNCE is just around the corner and this year it is in Nashville, TN. The RDPG has a number of events and educational seminars scheduled and we hope you can attend. Be sure to read your email blasts for more detailed information about the RDPG events at this year's FNCE.

Zinc's Role in Promoting Growth in Low- and Very Low Birth Weight Preterm Infants

LeeAnn Kindness
Graduate Student, Human Nutrition
Drexel 2016

INTRODUCTION

Thirteen million preterm babies are born in the world each year, many of whom are born with numerous life-threatening complications.[1] Of preterm infants, 70 percent are born at low birth weight (LBW).[2] LBW is a risk factor in 70 percent of perinatal deaths, 90 percent of neonatal deaths, and 50 percent of infant deaths.[3] Nutrient deficiencies are common in preterm infants. Specifically, 60 percent of zinc is deposited in the fetus in the third trimester, which leads to preterm infants being born with low zinc stores due to short gestational development.[4-6] Zinc is an important trace mineral responsible for over 300 biochemical processes and, thus, plays a vital role in the growth of preterm babies born with low birthweight (LBW) < 2500 grams and very low birth weight (VLBW) <1500 grams.[1] Zinc is a crucial component of hormones and proteins necessary for optimal growth, cell differentiation, metabolism, and function.[4,5] In addition, insulin-like growth factor 1 (IGF-1) and growth hormone receptor gene expression are impacted by zinc levels and subsequently are necessary for normal growth in early life.[5] However, preterm infants have a limited capacity to absorb and retain zinc due to feeding intolerances, immature digestive processes, and excessive endogenous losses.[5] Zinc supplementation higher than the recommended dietary allowance (RDA) has benefits for optimal catch-up growth in preterm infants.[1,3,5] This paper aims to examine the benefits of zinc supplementation on catch-up growth in preterm infants with LBW and VLBW.

LITERATURE REVIEW

Researchers have studied the human placenta to examine levels of important trace minerals and enzyme activity necessary for optimal growth in the human fetus.[1] Studies focus on zinc because of its profound role in cellular growth and proliferation.[1] Zadrozna et al reported weights of LBW infants were positively correlated to low zinc levels in the placenta.[7] Additionally, a positive correlation between LBW and low copper-zinc superoxide dismutase (Cu-Zn SOD) activity in the placenta was reported.[7] Cu-Zn SOD is a key enzyme in metabolic function and antioxidant activity.[8] This study examined placentas of full-term infants born at 37 weeks or later and preterm infants born between 34 and 37 weeks.[7] When Cu-Zn SOD activity was compromised, antioxidant functions were greatly reduced, leaving the preterm infants at high risk of infection and disease which inhibited optimal growth. The oxidative stress caused by decreased Cu-Zn SOD activity and low zinc in the placenta also contributed to the incidence of preterm birth.[7] With 60 percent of fetal zinc being acquired during the third trimester, the likelihood of zinc deficiency suggests further research into zinc supplementation in preterm infants to improve the rate of catch-up growth.[1] Islam et al performed a six-week randomized controlled trial to measure outcomes of growth via weight gain and height measurements in preterm infants less than 37 weeks receiving zinc supplementation.1 Each subject weighing between 1000 g and 2500 g received 2 mg/kg/day of zinc orally in addition to a multivitamin. The study contained a control group which received only a multivitamin. Serum zinc levels were measured prior to supplementation and at the end of the trial. Results showed that infants receiving zinc supplementation experienced reduced incidence of diarrhea.[1] Because preterm infants are less efficient at zinc absorption and retention, reducing diarrhea can improve absorption of important nutrients needed to meet increased nutrient demands of preterm infants.[3] After six weeks of supplementation, serum zinc levels increased, instances of diarrhea decreased, and weight gain and height were higher in the zinc supplementation group.[1] Given the results of these studies, researchers hypothesize that zinc plays a role in increasing protein metabolism and optimizing antioxidant activity to aid in catch-up growth and survival of preterm infants.

To further address this hypothesis, researchers have conducted studies focusing on the impact of feeding and growth failure in preterm infants. Growth failure in preterm infants is a universal issue that has not been preventable.[9] In the first few weeks of post-natal life, a preterm baby may lose 8-15 percent of birth weight, while healthy weight, full term infants lose up to seven percent of their birth weight. [9] This pattern of growth failure is rarely reversed before the infant is sent home: between 1997-

2000, 124 Neonatal Intensive Care Units (NICU) reported 28 percent of preterm infants were discharged with a weight below the 10th percentile.[9] Inadequate zinc intakes have been linked to exclusive breastfeeding in preterm infants most likely because serum zinc levels decline in exclusively breast fed preterm infants.[6] The study of zinc concentrations in human milk is necessary to determine post-natal intakes and growth outcomes.[1] Research has evaluated the concentrations of zinc in breast milk fed to preterm infants and determined human milk with fortifiers is required to meet nutritional requirements in preterm infants.[9] A recent study examined the effects of zinc supplementation in mothers of preterm infants to determine if maternal zinc supplementation affects zinc concentration in preterm milk.[4] After administering 50 mg zinc chelate to nursing mothers of preterm infants, no significant difference was found in maternal milk zinc levels in the supplemented group or the placebo group.[4] Therefore, to date, no clinical evidence supports recommending zinc supplementation to mothers of preterm infants.

More recent research has examined how an oral supplement of zinc plays a role in catch-up growth in preterm LBW and VLBW infants. It has been observed that preterm infants born before their zinc stores are optimal are at increased risk for health problems related to zinc deficiency such as growth retardation, diarrhea, and immune system defects.[4] Studies that measured the rate of catch-up growth in preterm LBW infants supplemented with zinc have demonstrated positive outcomes. A zinc supplementation study aimed at reducing morbidity in VLBW preterm infants also resulted in a secondary outcome of positive growth in the zinc supplemented group.[5] The subjects received 9.7-10.7 mg/zinc/day via enteral or parental feedings regardless of the infant's weight.[5] The zinc supplemented group had higher body weights at discharge than the placebo group.[5] Zinc also has a direct effect on IGF-1 and cell proliferation.[5,8,10] Given that IGF-1 plays an important role in early growth as the main growth hormone mediator, researchers attributed the increase in body weights of the VLBW infants receiving zinc supplementation to an increase in IGF-1.[5,8] A double-blind, placebo controlled study examining catch-up growth as a primary outcome in preterm LBW infants supplemented orally with 10 mg/zinc/day for 12 months exhibited increased growth rates and an increase in serum IGF-1 at six months.[10] A similar study examined the growth in LBW infants that were born at full term. At full term, these infants did not benefit substantially from oral zinc supplements.[3] In this study, zinc supplementation was administered at 5 mg/kg/day, lower than other studies administering higher amounts of zinc to preterm infants.[3] These findings indicate a positive relationship between low zinc stores in preterm infants and positive growth effects exhibited by a high dose zinc supplementation. Because full term LBW infants with higher post-natal zinc stores did not experience increased growth with supplementation in this trial, these findings may also suggest a positive correlation in the amount of zinc used for supplementation and growth outcomes. In general, these preliminary trials support the use of oral supplementation of zinc in preterm infants to aid in growth and demonstrate the need for recommended supplementation amounts to be further researched.

LIMITATIONS

Research on effective supplementation levels and the mechanism affecting growth outcomes in preterm infants is limited by differences in levels of supplementation, method of administering supplementation, studies of short duration, small sample size, and limited population demographics.[1-7,10] Regardless of the fact that zinc supplementation has shown a positive impact in growth and weight in preterm infants, studies have been unable to attribute this outcome to a specific mechanism. The positive outcomes could be explained by an observed increase in IGF-1, a decrease in diarrhea, and an increase in cell proliferation and protein metabolism.[1,5,7,10] In many of the studies, measurements of serum levels prior to supplementation were not performed, leaving the presence of an actual zinc deficiency unestablished.[3,4,5,10] Furthermore, studies were conducted in developing countries limiting the generalization of findings. None of the studies took into account maternal prenatal care or diet, which could vary based on the populations' demographic, geographic, and socioeconomic status. Specific

populations of LBW and VLBW preterm infants may not be generalized to other infants with different gestational ages or body weights. Many were small observational or supplementation studies that were limited when zinc was administered independently without surveillance and long-term follow-up. Thus, larger, prospective and randomized controlled trials are warranted.

FUTURE DIRECTIONS

With strong evidence supporting zinc supplementation and its positive outcomes on preterm infant growth, the scientific community should continue to focus on research investigating the responsible mechanism(s) and determine proper supplementation methods and amounts. Researchers theorize that zinc affects growth hormones and protein metabolism, aiding in catch-up growth in preterm infants. However, this outcome has not been observed in infants that are born full term with LBW leaving an area of research open to explore the potential mechanism(s) responsible.[3] In order for this theory to be confirmed, researchers must conduct larger studies that measure all macronutrient levels, growth hormone levels, and rate of protein metabolism in both preterm LBW and full term LBW infants. In addition, studies should be performed to determine proper supplementation levels, as we have observed the current RDA is not as beneficial as higher doses of zinc in this population. Zinc supplementation is beneficial for positive growth in LBW and VLBW preterm infants, with no side effects observed to date.[1,3,4,6-8,10]

CONCLUSION

The high prevalence of preterm infant births at LBW and VLBW merits the need for investigating the role zinc plays in positive outcomes for growth. Observations have associated increased IGF-1 levels along with other growth hormones, antioxidant activity, and increased protein metabolism during zinc supplementation with positive growth outcomes in preterm infants. Further studies determining recommended daily intakes of zinc supplementation and the specific populations that would benefit from them should be conducted to aid pediatricians in their treatment regimen of preterm infants of LBW and VLBW status.

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Pioneers in Professional Dietetics – Third in a Series

Susie King Taylor: Nurse and Educator of African American Civil War Soldiers

Author: Danielle M. Torisky, PhD, RD

Diaries, letters, and other primary sources are essential in historical research, and one of the most remarkable collections in Civil War food and medicine is *Reminiscences of My Life in Camp with the 33rd United States Colored Troops Late 1st South Carolina Volunteers* by Susie King Taylor.[1] Born into slavery from Georgia in 1848, Susie was secretly taught to read and freed during the early years of the Civil War. She was only 14 years old when she signed on as a laundress in 1862 for Company E of the 1st South Carolina Volunteers. Her duties quickly expanded to teaching off-duty soldiers how to read, preparing food, packing supplies, and tending wounded and sick soldiers. She stayed active in the education of African Americans after the war and was devoted to the needs of beloved comrades, both black and white veterans, until her death in 1912. The following are selected excerpts that earn Mrs. Taylor an honored place in dietetics history:

Packing food for transport. In June 1864, "…orders were received for the boys to prepare to take Fort Gregg, each man to take 150 rounds of cartridges, canteens of water, hard-tack, and salt beef… I helped as many as I could to pack haversacks and cartridge boxes."[1, p.89]

Modifying a recipe. Returning from the above battle, men were badly wounded. "My work now began. I gave my assistance to try to alleviate their sufferings. I asked the doctor at the hospital what I could get for them to eat. They wanted soup, but that I could not get; but I had a few cans of condensed milk and some turtle eggs, so I thought I would try to make some custard. I had doubts as to my success, for cooking with turtle eggs was something new to me, but … the result was a very delicious custard. This I carried to the men, who enjoyed it very much."[1, pp.90-91]

Professional networking. "When at Camp Shaw, I visited the hospital in Beaufort, where I met Clara Barton. There were a number of sick and wounded soldiers there, and I went often to see the comrades. Miss Barton was always very cordial toward me, and I honored her for her devotion and care for those men." [1, p.67]

Job description. "I was enrolled as company laundress, but I did very little of it, because I was always busy doing other things through camp, and was employed all the time doing something for the officers and comrades."[1, p.91]
Her service to the US Army could be described as multi-skilling at its finest.
Salary. "I gave my services willingly for four years and three months without receiving a dollar. I was glad, however, to be allowed to go with the regiment, to care for the sick and afflicted comrades." [1, p. 52]

Active in Retirement. In the late 1890s, she herself gave food aid to US troops engaged in Cuba. "I helped to pack boxes to be sent to the soldiers and hospitals during the first part of the Spanish war; there were black soldiers there too." [1, p. 137]

To learn more about Susie King Taylor and other African American men and women who provided food and medical care during the Civil War, go to the National Institutes of Health, US Library of Medicine's "Binding Wounds, Pushing Boundaries: African Americans in Civil War Medicine" website at http://www.nlm.nih.gov/exhibition/bindingwounds/index.html. For educators and researchers, this is a treasury of images, biographies, and educational resources.

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Summer 2015 Digest Spotlight

Shalene McNeill, PhD, RD

Shalene McNeill, PhD, RD

Our spotlighted member for this edition is Shalene McNeill, PhD, RD. Dr. McNeill is the Executive Director of Human Nutrition Research at the National Cattlemen's Beef Association (a contractor to the Beef Checkoff Program). In her current position, she directs the national human nutrition research program for the Beef Checkoff Program and also serves as the lead nutrition science communicator for the National Cattlemen's Beef Association. Read below to hear about Dr. McNeill's unique career story and her challenge as a young nutrition professional to read and know the research and be able to effectively communicate it to others.

Dr. McNeill, please tell us about your background. How did you get to where you are now?

Growing up around agriculture, I always had an interest in the practical application of science. I attended Texas A&M University where I earned a Bachelor's Degree in Biomedical Science. Initially, I thought I wanted to become a Physician Assistant (PA); however, some of my early graduate classes were in nutritional science and that changed everything for me. I loved the practicality of nutritional science and the ability to apply research to people's everyday lives and diets. Rather than pursue the PA route, I transitioned to a PhD program in Human Nutrition in the Department of Poultry Science at Texas A&M University where my research was focused on improving laying hen rations to result in an omega-3 fatty acid enriched egg that would offer people an alternative source to fish for these healthful fatty acids. It was during my PhD program that I also completed my dietetic internship, which was invaluable for giving me a complete perspective of the food landscape – from foundational nutrition research to the application of this science to dietary patterns and individualized nutrition.

Could you please summarize your current research for us?

Rather than actual bench work, my research role is focused on furthering the understanding of beef's role in health by identifying human nutrition research priorities, developing a national research plan, investing farmer and rancher research dollars in high quality research and ensuring the accurate communication of beef nutrition science. This offers me the unique ability to interact with nutrition researchers and their teams, including RDs, from across the country.

How did you become involved/ interested in your current line of research?

I became intrigued with the disconnect between the conventional wisdom and the scientific evidence about egg's role in health while working on my PhD in poultry and egg nutrition. Serendipitously, soon after earning my PhD, I was asked to provide a critical review of the nutritional attributes of beef. Sometimes you just get lucky and end up in the right place at the right time. Through my research on this project, I realized eggs and beef have strikingly similar science stories. I even found that some of my own personal biases about red meat's role in health were challenged through my review of the scientific literature. This work also introduced me to cattle farmers and ranchers and led me to my career as a beef nutrition research scientist and communicator. I have so much respect for America's farmers and ranchers. They are truly "salt of the earth," and they have never wavered in their commitment to science and to using nutrition research as the foundation for communicating accurate information to the public about beef's role in health.

Dr. McNeill, what advice would you give to a young researcher for developing a successful line of research?

Do the work, know your stuff and be able to communicate its meaning to others. There's really no short cut in developing a successful line of research or a successful career in nutrition science.

What are your career goals?

To always do work I am passionate about with good people who believe in doing the right thing.

How has your affiliation with the Academy impacted your career progression?

Without a doubt, my Academy affiliation helps me do my job well. The Academy -- at the national, state and local level -- has given me growth and leadership opportunities and has also helped me develop a network of colleagues to share the successes and challenges that come with a career in nutrition science.

If someone were to ask you to explain why research is important to the field of dietetics, what would you say?

It's the foundation for everything we do. As RDs, we must communicate evidence-based nutrition information to consumers, and we must ensure our perspectives are based on sound, long-standing science. We can't be credible or meaningful in our recommendations without the science to back them up. That's one of the many reasons I'm so proud to work with the beef community, because our work is always grounded in science

Happy Summer!

Elizabeth J. Reverri, PhD, RD
Research DPG Treasurer 2014-2016

Elizabeth J. Reverri, PhD, RD

Happy Summer!
We are putting the finishing touches on our budget for the 2015-2016 fiscal year and will publish the details in the quarterly newsletter, The Digest, this fall.

Membership dues provide income for the Research DPG, and a reserve level of 144% keeps the Research DPG in good standing. Recent expenses include the winter newsletter, executive committee conference call, and leadership training webinar for our incoming chair.

We continue to look for sponsors to help fund activities for the upcoming year, including a networking reception event and membership breakfast meeting at FNCE, website sponsorship, and/or sponsorship of The Digest. Please email sponsorship inquiries to Chair-elect Karin Pennington, MS, RD, FAND: Karin.Pennington@gmail.com.

As always, please email me with any questions: EJReverri@gmail.com.

Research DPG 2014-2015 Budget

		Annual Budget (in $)	As of March 2015 (in $)
Revenue	Membership Dues	18,250	17,323
	Meeting Registration	---	135
	Grants/Contracts	---	4,700
		18,250	22,158
Expenses	Lodging & Subsistence	924	1,587
	Transportation	6,000	3,848
	Professional/Consulting	3,000	2,903
	Postage/Mailing Services	50	42
	Teleconferences	135	213
	Webex Seminars	588	392
	Advertising/Promotion	250	99
	Member Dues & Fees	1,062	885
	Outside Services	4,400	200
	Academy Foundation Donation	100	0
	Awards	3,100	4,545
	Audio Visual Services	2,000	1,720
	Expo/Meeting Services	400	400
	Food Service	6,000	5,484
	Printing/Copying Services	250	668
		28,259	22,986
	NET	**-10,009**	
Reserve	**March 2015 Reserve**	**28,259**	**40,701**
	Reserve Percentage	**---**	**144%**

Website Committee Report

Elizabeth Parker, PhD, RD, 2014-2015 Website Committee Chair
Nicole Litwin, MS, RD, 2014-2015 LinkedIn Coordinator

Last spring, a survey that included questions about how the RDPG could improve its website was sent to members. From your feedback, the primary concerns regarding the RDPG website was a lack of resources and outdated content. Also, some members were unaware of the RDPG website or had experienced technical issues. As a result, one of our major initiatives this year was to make the website a more valuable resource for you as a member. Behind the scenes the website committee is hard at work ensuring we complete this mission. We submitted a Request for Proposal to web developers and are in the process of deciding on a company who will work with us to enhance and improve the RDPG website. By the time this issue is printed, we should have a final decision and a contract in place! Thank you for being patient with us during this time. And don't forget to visit our website! http://www.researchdpg.org/

Research DPG: Question and Answer

Assessing Body Fatness in Obese Adolescents: Alternative Methods to Dual-Energy X-Ray Absorptiometry

Answers

1. b	6. b
2. d	7. a
3. b	8. d
4. a	9. c
5. c	10. b

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Participant Name: _____

RD/RDN/DTR Number: _____

Session Title: Assessing Body Fatness in Obese Adolescents: Alternative Methods to Dual-Energy X-Ray Absorptiometry

CDR Activity Number: 119747 (Expires 6/01/2018)

Date Completed: _____ CPEUs Awarded: 1.0

Learning Need Code: _____ CPE Level: 2

Diane M. Enos, MPH, RDN, FAND

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Learning Need Code: _____ CPE Level: 2

Diane M. Enos, MPH, RDN, FAND

Provider Signature

PROVIDER #: AM003

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Research DPG Awards

Three Graduate Student Research Awards Sponsored by DuPont Nutrition and Health/Research DPG

The top three winners will receive a 1st - 3rd Place Ribbon/Certificate and $500 award each.
Application deadline: August 15, 2015

Research Pilot Award Sponsored by The Sugar Association/Research DPG

$3000 award
Application deadline: July 1, 2015

Research Pilot Award Sponsored by DuPont Nutrition and Health/Research DPG

$1500 award
Application deadline: July 1, 2015

Published Paper First Author Award

No monetary award
Application deadline: July 1, 2015

Published Paper Junior Faculty Author Award

No monetary award
Application deadline: July 1, 2015

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