MÁRIO EUGÉNIO TCHAMO

EFEITO DO PESO AO NASCER SOBRE A COMPOSIÇÃO CORPORAL, INDICADORES ANTROPOMÉTRICOS, APTIDÃO FÍSICA E COORDENAÇÃO MOTORA DE CRIANÇAS COM IDADE ENTRE 7 – 10 ANOS RESIDENTES NA CIDADE DE MAPUTO/MOÇAMBIQUE

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Tese apresentada ao Programa de Pós-Graduação em Nutrição do Centro de Ciências da Saúde da Universidade Federal de Pernambuco, para obtenção do titulo de Doutor em Nutrição

Orientadora: Prof. Dra Carol Góis Leandro

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MÁRIO EUGÉNIO TCHAMO

Efeito do peso ao nascer sobre a composição corporal, indicadores antropométricos de estado nutricional, aptidão física e coordenação motora de crianças moçambicanas na idade entre 7 – 10 anos residentes na cidade de Maputo/Moçambique

Tese aprovada em 22 de Fevereiro de 2016

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Resumo

O presente estudo teve como objetivo, avaliar a influência do baixo peso ao nascer sobre a antropometria, composição corporal, aptidão física e coordenação motora em crianças de 7 – 10 anos residentes na cidade de Maputo, Moçambique. Um total de 353 crianças de 7 a 10 anos de idade de ambos os gêneros particiciparam deste estudo. A amostra foi dividida em dois grupos de acordo com o peso ao nascer: baixo peso ao nascer BPN de 1500 a 2500 g (n=155) e peso normal ao nascer PN de 3000 a 3999 g (198). As medições de composição corporal incluiram peso corporal, altura, índice de massa corporal, massa gorda, massa magra, percentagem de gordura corporal, pregas de adiposidade e circunferências de cintura, de braço e geminal. Os indices peso/idade, altura/idade, peso/altura foram utilizados para indicadores antropométricos do estado nutricional. A aptidão física foi avaliada por força de preensão manual, flexibilidade, resistência abdominal *(curl up),* salto horizontal e corrida de velocidade. A coordenação motora grossa foi avaliada pelas médias de KorperKoordination Test fur Kinder (KTK). Usando o t test, o grupo BPN demonstrou baixos valores na massa corporal e altura, índice de massa coprporal (IMC) e massa livre de gordura, reduzidos índices de peso/idade e altura/idade, circunfêrencia de braço e de geminal e força da mão e transfêrencia lateral quando comparado com o PN. O grupo BPN apresentou melhores resultados no equilíbrio que PN. Utilizando o Ancova, o Peso corporal, altura, IMC, peso/idade, permaneceram significantes mesmo depois de ter sido ajustados por idade, género, tamanho do corpo, conjunto das dobras de adiposidade. As diferenças na força da mão e transferência lateral permaneceram significante mesmo depois de controlar por idade, género, tamanho do corpo e conjunto das pregas de adiposidade. BPN parece ser o principal fator que influencia a antropometria, mas não a aptidão física e componentes neuromotores.

Palavras chaves: Peso ao nascer, Moçambique, crianças, aptidão física, coordenação motor

Abstract

To evaluate the influence of the low birth weight on anthropometry, body composition, physical fitness and gross motor coordinationof schoolchildren aged 7-10 years old from Maputo, Mozambique. A total of three hundred fifty-three 7 to 10 years old children from both gender were invited to participate in this study. The sample was divided into two groups according to their birth weight: low birth weight (LBW) from 1.500 g to 2.500 g (n=155) and normal birth weight (NBW) from 3.000 g to 3.999 g (n=198). Body composition measurements included body weight, height, body mass index (BMI), fat mass, lean mass, body fat percentage, skinfold thickness and waist, arm and geminal circumferences. The indices weight-for-age, height-for-age and weight-for-height were assessed. Physical fitness was assessed by handgrip strength, flexibility, curl up, long jump and running speed.Gross motor coordination was evaluated by means of the KorperKoordination Testfur Kinder (KTK). LBW group showed a lower body weight and height, BMI and fat free mass, reduced index weight-for-age and height-for-age and circumferences of arms and geminal, and a reduced handgrip strength and sideway movements when compared to NBW group. LBW group showed a better performance in balancing backwards test than NBW group. Body weight, height, BMI, weight-for-age and height-for-age remained significant even after adjusted for age, gender, body size and fatness skinfold thickness (FST). The differences in handgrip strength and sideway movements remained significant even after controlling for age, gender, body size and FST.

Keywords: Birth weight, stunting, Mozambique, children, physical fitness, motor coordination

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Lista de abreviaturas e siglas

BPN – Baixo peso ao nascer

PN- Peso normal ao nascer

EBPN – Extremo baixo peso ao nascer

MBPN – Muito baixo peso ao nascer

IMC – Índice de Massa Corporal

DOHaD - Origem desenvolvimentista da saúde e da doença

CAPES - Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

CNBS – Comité Nacional de Bioética e Saúde

MG – Massa Gorda

MM – Massa Magra

% Gord. Percentual de gordura

DNM - Desenvolvimento neuro motor

KTK - Körperkoordinations-test für Kinder

ANCOVA - Análise de covariância

FST – Soma das pregas

WHO - Organização Mundial de Saúde

MQ – Quociente Motor

BMI – Índice da massa corporal

FFM – Massa livre de gordura

AptFS - Avaliação da aptidão Física

Sumário

1. APRESENTAÇÃO

1. Apresentação

O peso ao nascer tem sido considerado um importante indicador no aparecimento precoce de doenças cardiovasculares e metabólicas (BARKER, OSMOND *et al.*, 2009; GONZALEZ-JIMENEZ, MONTERO-ALONSO *et al.*, 2015). O baixo peso ao nascer (BPN) está associado ao *catch up* de crescimento, ou acumulação de gordura durante a infância que tem consequências adversas na vida adulta. (EKELUND, ONG *et al.*, 2007). No Brasil, um estudo avaliou crianças de 0 a 3 anos de idade e os resultados apontaram catch up de crescimento (ALVES, VASCONCELOS *et al.*, 2015). Da mesma forma em Gana um estudo analizou o crescimento de crianças BPN de 0 a 9 anos de idade e observou um catch up de crescimento (VAN DER MEI, VOLMER *et al.*, 2000). Este problema pode estar associado com um aumento do risco de obesidade na infância, complicações metabólicas e intolerância a glicose.

Existe uma relação entre BPN e intolerância a glicose (MANZONI, BAU *et al.*, 2007). Na África do Sul, estudo realizado com crianças de 7 anos de idade encontrou uma tolerância a glicose comprometida e pressão sanguínea elevada (CROWTHER, CAMERON *et al.*, 1998). Existem sugestões que apontam a atividade física pode modificar a associação entre BPN e o risco metabólico (ERIKSSON, YLIHARSILA *et al.*, 2004). De acordo com a organização mundial de saúde, os individuos podem se beneficiar com a prática de atividade física melhorada e o risco reduzido para o começo de doenças cardiovasculares e diabetes tipo 2 (WHO, 2008).

Baixos níveis de atividade física parecem afetar a aptidão física. Aptidão física é definida como a habilidade para realizar a atividade física diária sem a fadiga excessiva e está associado com baixo risco de desenvolver deonças hipocinéticas (WILDER, GREENE *et al.*, 2006). Os componentes de aptidão física são aptidão cardiorrespiratória, força muscular, flexibilidade e composição corporal (DOURIS, CHINAN *et al.*, 2004). A relação entre peso ao nascer e aptidão física tem sido relatado em estudos prévios (ROGERS, FAY *et al.*, 2005). O BPN foi associado com a reduzida performance física, incluindo força muscular e resistência muscular (INSKIP, GODFREY *et al.*, 2007; YLIHARSILA, KAJANTIE *et al.*, 2007; ORTEGA, LABAYEN *et al.*, 2009; RIDGWAY, ONG *et al.*, 2009). Também apresentaram grandes dificuldades coordenativas. Ainda não existem estudos em países africanos analisando a relação entre BPN e atividade física.

Uma das questões de atividade física está associado com o desenvolvimento neuromotor, por isso dificuldades motoras são comuns em crianças extremo baixo peso ao nascer (HOLSTI, GRUNAU *et al.*, 2002). Um estudo realizado em Canadá, concretamente na Columbia Britânica, avaliou crianças aos 9 anos de idade, 51% de crianças extremo baixo peso ao nascer (EBPN > 1000g) demonstraram desordens no desenvolvimento da coordenação comparado com apenas 5% de crianças controle (HOLSTI, GRUNAU *et al.*, 2002). Mesmo assim, nesta questão os estudos são controversos em relação ao BPN. Em Moçambique não existem estudos relacionando desenvolvimento BPN e neuromotor.

Na cidade de Maputo – Moçambique, a prevalência de BPN é de 10,8 % (ESTATISTICA, 2011). Estudos em Moçambique somente descreveram a antropometria, a atividade física e aptidão física das crianças (PRISTA, MAIA *et al.*, 2003; NHANTUMBO, 2013; DOS SANTOS, MAIA, GOMES, DACA, MADEIRA, DAMASCENO *et al.*, 2014). Deste modo, este estudo foi norteado pela seguinte pergunta condutora: pode o peso ao nascer influenciar a composição corporal, indicadores antropométricos de estado nutricional, aptidão física e coordenação motora de crianças? Assim, o objetivo deste estudo foi de avaliar a influência do peso ao nascer sobre a antropomentria, composição corporal, aptidão física e coordenação motora grossa de crianças de 7 – 10 anos de idade residentes na cidade de Maputo, Moçambique.

O presente estudo foi realizado em bairros periféricos da cidade de Maputo. Maputo localiza - se na parte sul de Moçambique e é a capital do país. Foram orientadores deste estudo a prof[a]. Dra. Carol Virgínia Góis Leandro e o Prof[o]. Catedrático António Prista. A pesquisa de campo foi realizada em colaboração com o laboratório de Fisiologia da Universidade Pedagógica de Moçambique.

Esta pesquisa gerou 2 artigos. O primeiro artigo intitulado: "*Low birth weight, very low birth weight and extremely low birth weight in African children aged between 0 – 5 y old: a systematic review":* foi enviado para a publicaçao na revista Journal of Developmental Origins of Health and Disease (DOHaD). Está revista é classificada com Qualis B2 no comitê de Nutrição da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). Este estudo será utilizado como revisão de literatura da tese.

O Segundo artigo é apresentado como resultado da pesquisa e está disponível na sua versão original. Este artigo: "*Persistent deficits in anthropometric indices of nutritional status and motor performance in low birth weight children from Maputo city, Mozambique":* foi submetido como artigo original para a publicação na revista: Developmental Medicine and Child Neurology. Essa revista possui Qualis A2. Em síntese, nesse artigo verificou-se que o peso ao nascer não pode ser considerado isoladamente, um determinante biológico do crescimento físico, composição corporal e alguns componentes da aptidão física.

Ainda no âmbito deste trabalho, um artigo que trabalhou na mesma temática, mas com jovens foi publicado. O artigo foi publicado na Revista Brasileira de Medicina de Esporte intitulado*: Physical fitness and birth weight in young men from maputo city, mozambique.Rev Bras Med Esporte – Vol. 22, No 1 – Jan/Fev, 2016.* Mário Eugénio Tchamo, Marcos André Moura dos Santos, Marcelus Brito de Almeida, António Manuel Machado Prista e Silva e Carol Góis Leandro (Anexos).

Estrutura da tese

Esta tese esta estruturada em cinco capítulos. O primeiro compreende a apresentação do estudo que se centra na fundamentação teórica e justificativa e apresenta ainda questões fundamentais e os objetivos do estudo. O segundo capítulo é composto pelo artigo de revisão que procura analisar as repercussões do baixo peso ao nascer e a sua relação com o crescimento, desenvolvimento neurológico e mortalidade nas crianças africanas e aptidão física de crianças. O terceiro capítulo refere-se à metodologia empregada no presente estudo. O quarto capítulo congrega o estudo original, apresentado sobre a forma de artigo, em concordância com a norma da revista para onde foi submetido, um estudo que procura responder ao principal objetivo desta tese. Por fim, o quinto capítulo que apresenta as principais conclusões do estudo, salientando as suas implicações, bem como os desafios e as perspectivas. As referências são apresentadas ao final de cada capitulo. A tabela 1 apresenta sumariamente a estrutura da tese.

Tabela 1. Estudos que compõem os capítulos da TESE e seus principais objetivos

Capitulo 1	Apresenta a introdução geral, a pertinência do estudo e as questões fundamentais acerca dos objetivos da pesquisa.
Capitulo 2	Faz referência a Revisão da Literatura Artigo de Revisão: Low birth weight, very low birth weight and extremely low birth weight in African children aged between 0 – 5 y old: a systematic review *Journal of Developmental Origins of Health*

	and Disease.
Capitulo 3	Apresenta a Metodologia empregada no estudo
Capitulo4	Apresentação dos Resultados Artigo Original - Persistent deficits in anthropometric indices of nutritional status and motor performance in low birth weight children from Maputo city, Mozambique *Developmental Medicine and Child Neurology*
Capitulo 5	Conclusões e perspectivas
Anexos	

2. REVISÃO DE LITERATURA

2. Revisão de literatura

Title: Low birth weight, very low birth weight and extremely low birth weight in African children aged between 0 – 5 y old: a systematic review

Short-title: Birth weight in African children

Abstract

Background: Low birth weight (LBW<2500 g), very low birth weight (VLBW<1500 g), extremely low birth weight (ELBW<1500) infants are at high risk for growth failure that result in delayed development. Africa is a continent that has high rates of children born with LBW, VLBW and ELBW particularly sub-Saharan Africa. *Aim:* To review the existing literature that explores the repercussions of LBW, VLBW and ELBW on growth, neurodevelopmental outcome, and mortality in African children aged 0 – 5 y old. *Methond:* A systematic review of peer-reviewed articles using Academic Search Complete in the following databases: Pubmed, Scopus and Scholar Google. Quantitatives studies that investigated the association between LBW, VLBW, ELBW with growth, neurodevelopmental outcome and mortality, published between 2008 and 2015 were included. African studies with humans were eligible for inclusion. From the total of 2205 articles, 12 articles were identified as relevant and were subsequently reviewed in full version. *Findings:* Significant associations were found between LBW, VLBW and ELBW with growth, neurodevelopmental outcome and mortality. *Conclusion:* Surviving VLBW and ELBW showed increased risk of death, growth retardation, and delayed neurodevelopment. Post-neonatal interventions need to be carried out in order to minimize the short-term effects of VLBW and ELBW.

Keywords: Newborn children, birth weight, African children, growth

Introdution

Africa is a continent that has high rates of children born with low birth weight, particularly sub-Saharan Africa and recent studies have shown a high rate of mortality for low birth weight (RYLANCE e WARD, 2013; ANDERSEN, JENSEN *et al.*, 2014; SANIA, SPIEGELMAN *et al.*, 2014). Low birth weight (LBW) is defined as a birth weighing 500 grams but below 2500 grams irrespective of gestational age(WARDLAW T, 2004; SAY, DONNER *et al.*, 2006; GOLDENBERG e CULHANE, 2007). At the extreme end of LBW, a distinction is made of very LBW (VLBW), depicting infants less than 1500 g and extremely LBW (ELBW), depicting infants less than 1000 g(BALLOT, POTTERTON *et al.*, 2012). VLBW and ELBW infants are at high risk for growth failure and co-morbidities that result in delayed neurodevelopment and academic achievement (HACK e KLEIN, 2006; HORBAR, CARPENTER *et al.*, 2012; LITT, GERRY TAYLOR *et al.*, 2012).

It is estimated that in sub-Saharan Africa, LBW represents14.3 % that is almost twice of the rate of European countries (NAMIIRO, MUGALU *et al.*, 2012). A study performed in Congo showed that rates of LBW children were 164 per 1000 alive births in Kama, and 270 per 1000 in Kipaka (MILABYO KYAMUSUGULWA, 2006). In Jimma, southwestern of Ethiopia, it was found a prevalence of 22.5 % LBW around 145 newborn infants (TEMA, 2006). In Zimbabwe, a study found a prevalence of 12.9 % of LBW children (TICCONI, ARPINO *et al.*, 2005). Because there is a high percentage of LBW in Sub-Saharan Africa, it is important to assess the impact during the stages of growth of those children.

Growth evaluation during the neonatal period is determined by the changes in anthropometric measurements and the body weight gain is a valuable guide to indicate an adequate growth (RUGOLO, 2005). The change in the body weight during the neonatal period of LBW children is characterized by an initial loss of approximately 8-15% in the first 7 days of life followed by a recovery that occurs around 10 to 21 postnatal day(GARN, 1985).

The body weight loss in the postnatal period is higher in VLBW and ELBW children than normal children(GARN, 1985). Growth retardation or failure to recover body weight may occur due several factors that may be medical, nutritional or environmental (NAMIIRO, MUGALU *et al.*, 2012). This delay in growth or failure in the body weight regain may have consequences in adulthood.

VLBW and ELBW are associated with motor difficulties or developmental coordination disorders(POWLS, BOTTING *et al.*, 1995; HOLSTI, GRUNAU *et al.*, 2002).Insufficient attention has been paid to the prevention and control of LBW in Africa, particularly programs that target VLBW and ELBW infants. Data are required to advocate intervention studies in Africa. Thus, the main goal of the present study was to analyze the repercussions of the low, very low and extreme low birth weight in Africa. This review will focus on studies that associate birth weight with the growth, neurodevelopmental parameters and mortality of African children.

Methods

Search strategy

A systematic review was carried out in the Pubmed, Scopus and Schoolar Google databases, using combinations of the following keywords: Africa, low birth weight, growth, neurodevelopment, mortality, children (Pubmed); low birth weight, mortality, African children, growth, motor neurodevelopment (Scopus and Scholar Google).

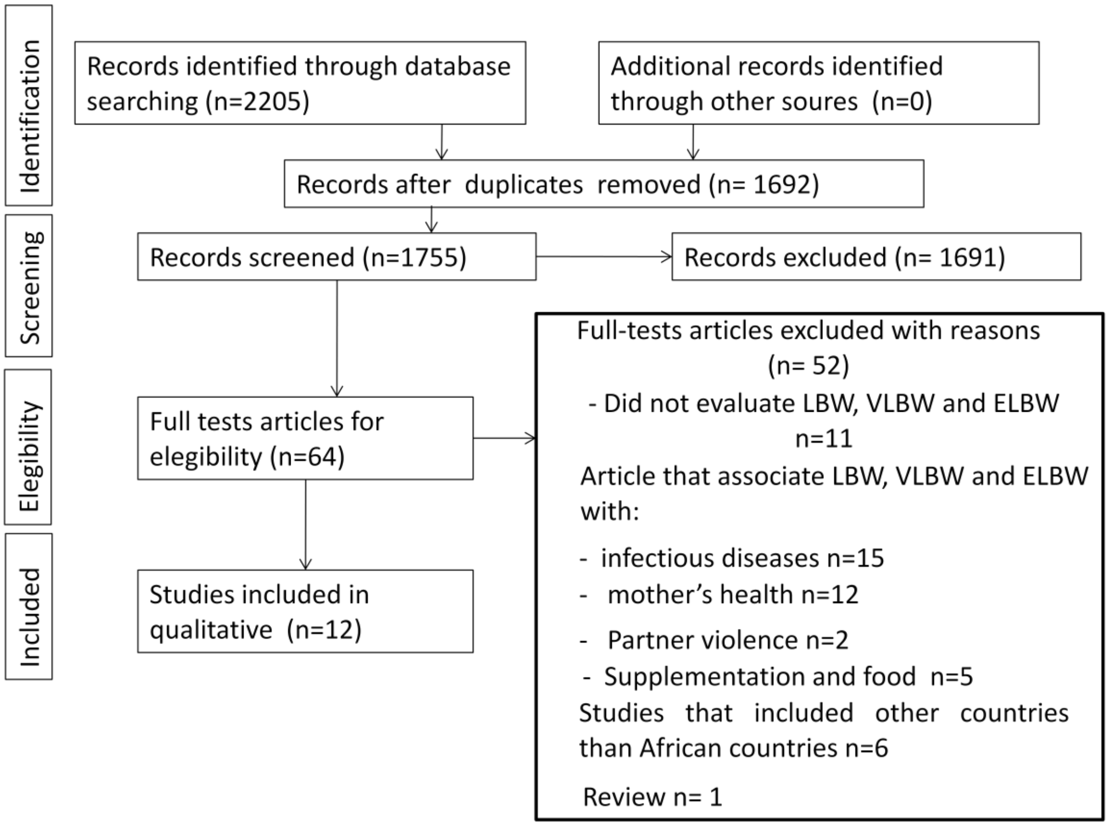
Inclusion and exclusion criteria

Articles were included in this review should be published in English language between January 2008 and September 2015. The characteristic of articles were:Africans, humans, LBW, VLBW, ELBW associated with growth, diseases and neurological disturbs. Original articles and available articles as full text were also criteria of inclusion. It was used as exclusion criteria: review articles, articles related to AIDS-HIV and infection diseases, alcohol, cigarettes, animals. Studies that linked LBW, VLBW and ELBW with supplementation of any medication, disease of sexual transmission, and domestic violence during pregnancy were excluded. Studies with other countries than African countries were excluded. Articles without abstract and out of the study period were excluded. Newborns were classified as low birth weight(LBW< 2,500 g), very low birth weight(VLBW< 1,500 g), and extremely low birth weight (ELBW< 1,000 g).

Seletion process

The flow diagram in Fig. 1 displays the process for selecting the studies of this review. The titles and abstracts were screened by two authors.The initial search resulted in a total of 1755 articles, of which 1691 were excluded after the title and abstract were read. Full texts of 64 articles were read, and a further 52 excluded due to ineligibility, leaving 12 papers appropriate for this review.

Fig.1. Flow of studies included in the review



Data abstraction

The relevant information from the studies are shown in three tables. All authors reviewed the summary of each study. Tables 1-3 sumarise studies that examined the associations among LBW, VLBW and ELBW with growth (Table 1), neurodevelopmental outcome (Table 2) and mortality (Table 3). The tables included information about the country of study, design, sample characteristics, objectives, methodology, and findings of each study.

Results

Association between LBW, VLBW and ELBW with growth

Five longitudinal studies (NJOKANMA, EGRI-OKWAJI *et al.*, 2008; MACKAY, BALLOT *et al.*, 2011; OLUSANYA e RENNER, 2011; NAMIIRO, MUGALU *et al.*, 2012; LANGO, HORN *et al.*, 2013) analyzed the association between LBW, VLBW and ELBW with growth, as presented in table 1. Studies included both VLBW and ELBW, age from 0 to

3 months. The measurements of growth differed among studies. Three studies (NJOKANMA, EGRI-OKWAJI *et al.*, 2008; MACKAY, BALLOT *et al.*, 2011; NAMIIRO, MUGALU *et al.*, 2012) used anthropometry to evaluate growth (OLUSANYA e RENNER, 2011; LANGO, HORN *et al.*, 2013). To calculate growth velocity, it was used the point system:

GV=[1000×(Wn−W1)]/{(Dn−D1)×[(W1+Wn)/2]}; where GV = growth velocity, W = weight in grammes, D1= beginning of time interval in days, Dn = end of time interval in days.

Two studies found association between birth weight and LBW, VLBW and ELBW presenting lower values than normal children (NJOKANMA, EGRI-OKWAJI *et al.*, 2008; MACKAY, BALLOT *et al.*, 2011). Of the 235 LBW infants, 113 (48.1%) remained with their body weight until 21 postnatal days(NAMIIRO, MUGALU *et al.*, 2012) and higher weight velocity associated with cath up growth was found in LBW children (OLUSANYA e RENNER, 2011).

Association between LBW, VLBW and ELBW with neurodevelopmental outcomes

Table 2 presents the studies that investigated the relationsip between LBW, VLBW, ELBW with neurodevelopmental outcomes(BURGER, FRIEG *et al.*, 2011; GLADSTONE, WHITE *et al.*, 2011). The spontaneous movements patterns was recorded by digital video camera (BURGER, FRIEG *et al.*, 2011) and the Ten Question Questionnaire were used to asses development and disability of children (GLADSTONE, WHITE *et al.*, 2011). A significant relationship was found between fidgety movement outcome and the infants' final motor outcome at 12 months (BURGER, FRIEG *et al.*, 2011). Preterm infants more often screened positively for disability on the Ten Question Questionnaire(GLADSTONE, WHITE *et al.*, 2011).

Association between LBW, VLBW and ELBW with mortality

Table 3 presents five studies that associated LBW, VLBW and ELBW with mortality (HONG e RUIZ-BELTRAN, 2008; RYLANCE e WARD, 2013; SANIA, SPIEGELMAN *et al.*, 2014; AHLSEN, SPONG *et al.*, 2015; BALLOT, CHIRWA *et al.*, 2015). The studies used different methods, two studies discribed the VLBW and ELBW survival (RYLANCE e WARD, 2013; AHLSEN, SPONG *et al.*, 2015), one study made similar study in two different period to analyze VLBW and ELBW survival (BALLOT, CHIRWA *et al.*, 2015) and two studies analyzed the mortality in LBW children (HONG e RUIZ-BELTRAN, 2008; SANIA, SPIEGELMAN *et al.*, 2014).Survival significantly increased with increasing birthweight and time of gestation(RYLANCE e WARD, 2013; AHLSEN, SPONG *et al.*, 2015). Survival in two period of study was similar (BALLOT, CHIRWA *et al.*, 2015). LBW children were about 3 times more likely to die in infancy than other children(HONG e RUIZ-BELTRAN, 2008; SANIA, SPIEGELMAN *et al.*, 2014).

Discussion

The findings of the relationship between birth weight and growth were relatively consistent across studies. Significant associations were found between LBW, VLBW and ELBW with lower values of growth (NJOKANMA, EGRI-OKWAJI *et al.*, 2008; MACKAY, BALLOT *et al.*, 2011; NAMIIRO, MUGALU *et al.*, 2012). Low birth weight, intrauterine growth retardation were significantly associated with growth impairment (GÉRAUD PADONOU, 2014). The growth of VLBW infants is characterized by early suboptimal growth followed by a period of catch up growth (NIKLASSON, ENGSTROM *et al.*, 2003). Rapid catch up growth is advantageous with respect to improved neurodevelopmental outcomes, fewer psychosocial problems in later childhood and lower risk of persistent short stature but may be associated with an increased risk of childhood obesity andother metabolic complications(HACK, SCHLUCHTER *et al.*, 2003; NIKLASSON, ENGSTROM *et al.*, 2003). The studies of this review presented some limitations, such as, lack of detailed information regarding length of hospital stay and time to regain birth weight. The studies had no control over timing of discharge and scheduling of follow-up dates. Since all recorded information were obtained from the mother and the available medical records, recall bias and incomplete documentation respectively, may have affected the results. Gestational age estimates were based on hospital records derived from parental accounts of last menstrual period which may be prone to errors.

Two prospective cohort studies analyzed the neurodevelopmental outcomes of studies and found associations among ELBW and VLBW and developmental delay(BURGER, FRIEG *et al.*, 2011; GLADSTONE, WHITE *et al.*, 2011). ELBW are prone to a range of long term complications in comparison to their born-at-term counterparts(AYLWARD, 2005; MARLOW, WOLKE *et al.*, 2005). These complications include: severe handicap such as cerebral palsy, cognitive impairment, blindness and hearing loss to impairment of short term memory, strabismus, language delays, learning difficulties and behavioural disorders(AYLWARD, 2005; DELOBEL-AYOUB, KAMINSKI *et al.*, 2006; HACK, 2007). Early intervention may not be able to change the physical outcome, such as cerebral palsy, in infants with neurodevelopmental disabilities, but a loss of, or delay in, the follow-up on high-risk infants could lead to secondary musculo skeletal impairments and a decline in mobility and functional abilities in children with cerebral palsy(PAPAVASILIOU, 2009).The method of malawi study MDTA and TQQ found intersting results, but more sophisticated tests are necessary to provide more details. The studies follow up the children only 2 years but the minimum age required for a proper distinction to be made between the normal trajectory, with slow motor development, and an abnormal pattern of development appears to be around 4 years of age(ROSENBAUM, 2006).

The current review found the association between LBW, VLBW and ELBW with mortality (HONG e RUIZ-BELTRAN, 2008; RYLANCE e WARD, 2013; SANIA, SPIEGELMAN *et al.*, 2014; AHLSEN, SPONG *et al.*, 2015; BALLOT, CHIRWA *et al.*, 2015). To born VLBW and ELBW is the most important cause of neonatal mortality(VELAPHI, 2012). In a study of 795 mother–infant pairs in rural Malawi, the odds of neonatal mortality among preterm babies was 11 times greater than that of term babies(KULMALA, VAAHTERA *et al.*, 2000).The studies of this review only investigated the short-term survival of the infants with LBW, VLBW and ELBW. There is no information about long-term survival or morbidity of the infants. Only one study provided information about cases of death (HONG e RUIZ-BELTRAN, 2008), others did not.

Limitations

This review does not provide data on long-term neonatal outcomes. We found studies untill 2 , 3 y old age. Lack studies that associated LBW, VLBW, ELBW and childhood, youthful and adulthood. In almost all countries, the studies were carried out at the reference hospitals which have a higher standard of care than most other hospitals in the countries, so it is bias to generalize the results. Gestational age estimation based on the date of last menstrual period depends on women’s recall ability and, therefore, there is a high probability of error. This might lead to differential misclassification in preterm birth leading to an underestimate of the true risk of mortality due to preterm birth.This review analyzed studies only in english and did not follow up the articles of onother languages.

Conclusion

The results of this review showed that for surviving VLBW and ELBW babies there is disadvantage with increased risk of death, growth retardation, and developmental delay. Post-neonatal interventions need to be carried out which might improve outcomes in this group of VLBW and ELBW. Hospitals must take this problems seriously increasing access to quality prenatal care.

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Table.1 List of studies that examined the repercussion of low birth weight (LBW), very low birth weight (VLBW) and excessive low birth weight (ELBW) with the indicators of growth in african continent between 2008 - 2015

Reference country	Participant characteristic: study design	Study aim	Measurement of growth achieved	Findings
Njokanma et al (2008)**(NJOKANMA, EGRI-OKWAJI *et al.*, 2008)** Nigeria	N= 89 preterm, 46 term. Age range 40 weeks Preterm grouped (Groups I,II,III,IV and V) 26/28, 29/30, 31/32, 33/34 and 35/36 weeks. Observational cohort longitudinal study	To describe the growth of ELBW, VLBW, LBW and NBW	Body weight, length and occipito-frontal circumference of 89 preterm, LBW, appropriate-for-dates infants were monitored from birth until 53 post-conceptual weeks. Growth velocities were compared with 46 terms	Initial weight loss, age at regaining birth weight and growth rate in the early postnatal weeks were inversely related to gestational age. Subsequent weight gain was directly related to gestational age. Between birth and 40 weeks post conception, growth rates for different gestational age groups were 129 to 207 g/week (weight), 0.78 to 0.93 cm/week (length) and 0.62 to 0.65 cm/week (head circumference). After 40 weeks, the corresponding rates were 188 to 238g/week, 0.86 to 0,96 cm and 0.48 to 0.50 cm/week, respectively.
Mackay et al (2011)**(MACKAY, BALLOT *et al.*, 2011)** South Africa	N= 139 VLBW (<1500g) Age range 3 months. Prospective cohort study	To assess the growth of a cohort of VLBW infants in Johannesburg.	Growth parameters, including body weight, length and head circumference were recorded at each visit by the same nursing sister.	At 12 months in variable weight AGA showed higher values than SGA (9.01 ± 1.31 vs 7.71 ± 1.26, p= 0.004). In lengths AGA showed higher values than SGA (72.51 ± 3.39 Vs 68.9 ± 4.23, p= 0.007). No difference was found between AGA and SGA in head circumference. (45.71 ± 1.16 Vs. 45.08 ± 1.54, p= 0.19).
Namiiro et al (2012)**(NAMIIRO, MUGALU *et al.*, 2012)** Uganda	N=235 Age range 21 days VLBW; ≤1500g = 88, >1500g = 147 Cross sectional study	To determine what proportion of LBW infants had not regained their birth weight by 21 days of age after discharge from the Special Care Unit of Mulago hospital, Kampala	Anthropometric measurements (weight, length and head circumference) and physical examination were carried out and recorded.	Of the 235 LBW infants, 113 (48.1%) did not regain their birth weight by 21 days. Hospital stay of more than 7 days (p value: 0.001) and initiation of first feed of more than 48 hours (0.034) were the significant factors that contributed to failure to regain birth weight among the study participants.
Olusanyaet al (2011)**(OLUSANYA e RENNER, 2011)** Nigeria	N= 142 Age range 45 days VLBW Cohort study	To determine the pattern and predictors of growth velocity in early infancy in a resource-poor setting.	Growth or weight velocity (GV) for each infant was computed based on three methods: 1) 2-point birth weight (BW) Model: net weight gain over the time interval divided by the time interval and BW, or estimated GV= [1000×(Wn−W1)]/[(Dn−D1)×BW]. 2) 2-point Average Weight (AW) Model: net weight gain over the time interval divided by the time interval and average weight, or estimated GV=[1000×(Wn−W1)]/{(Dn−D1)×[(W1+Wn)/2]}3) Exponential (Expo) Model: estimated GV=[1000×Ln(Wn/W1)]/ (Dn−D1).	High weight velocity was strongly associated with lower birth weight (p<0.001) indicative of “catch-up” growth as well as with higher gestational age (p<0.001)

Lango et al (2013)**(LANGO, HORN *et al.*, 2013)** South Africa	N= 51 Age range = 56 days ELBW [The median birth weight of the cohort was 875 (640–995) g]. Retrospective cohort study.	To describe the growth velocity of a cohort of ELBW infants and to compare with internationally acceptable benchmarks.	Growth velocity (GV) was determined from weekly weights starting from day 7 using the two-point system as shown below: $GV=[1000\times(Wn-W1)]/\{(Dn-D1)\times[(W1+Wn)/2]\}$	No difference between AGA e SGA p=0.52. The overall mean (SD) growth velocity was 14 (2.9) g/kg/day. In this cohort of ELBW infants, growth velocity was within the range currently deemed acceptable by international consensus.

WHO= World Health Organization; AGA = Appropriate for gestational age; SGA = Small for gestational age; p value determined using the unpaired t test; P<0,005. W = body weight in grams, D1 indicates the beginning of the time interval, Dn is the end of the time interval, in days. NBW – normal birth weight

Table 2. List of studies that examined the repercussion of low birth weight (LBW), very low birth weight (VLBW) and excessive low birth weight (ELBW) with neurodevelopmental outcomes in African continent between 2008 - 2015.

Reference country	Participant characteristic: study design	Study aim	Measures of psychological distress	Findings
Burger et al (2011)**(BURGER, FRIEG *et al.*, 2011)** South Africa	N= 115 Age range = during 12 months ELBW and VLBW ≤ 1250 g Prospective descriptive study	To assess the predictive validity of general movements during the fidgety movements'period in VLBW and ELBW infants admitted to TCH in Cape Town, South Africa	A light-sensitive digital video camera (JVCGR-DV4000) was used to record the infants' spontaneous movement patterns at 12 weeks corrected age (CA). The (PDMS-2), and the AIMS were used by author to assess the infants' fine and gross motor development at 12 months CA. A physician with 16 years experience at the TCH high-risk neurodevelopmental outpatient clinic performed a complete neurological examination, according to the procedure recommended by Amiel-TisonandGosselin	A significant relationship was found (p<0.01) between fidgety movement outcome and the infants'final motor outcome at 12 months corrected age.
Gladstoneet al (2011)**(GLADSTONE, WHITE *et al.*, 2011)** Malawi	N= 840 Age range 2 years Group 1 preterm BW<37 weeks Group 2 term BW 37-41 weeks Prospective cohort study and questionnaire Longitudinal	To assess four specific outcomes post neonatal survival, morbidity, growth, and development in a community-based sample of infants born after spontaneous preterm delivery in rural sub-Saharan Africa.	Development and disability were assessed using the TQQ and the MDAT. MDAT was used to assess children in two ways: through a pass/fail scoring system and through a numerical scoring system applied to each of four domains of development.	Preterm infants more often screened positively for disability on the Ten Question Questionnaire (p = 0.002). They also had higher rates of developmental delay on the MDAT at 18 months (p = 0.009). In terms of overall pass/fail on the MDAT, more children in the preterm group compared to the term group failed the MDAT at each stage of assessment; at 12 mo this was 6.7% versus 2.9% (p= 0.216), at 18 mo 22.8% versus 10.9% (p= 0.009), and at 24 mo 12.8% versus 10.7% (p =0.274). Significant differences were also found specifically at 18 mo for language development (p= 0.033).

BW – Birth weight, TCH - Tygerberg Children's Hospital; PDMS-2 - Peabody Developmental Motor Scale, second edition; AIMS - Alberta Infant Motor Scale; TQQ - Ten Question Questionnaire; MDAT - Malawi Developmental Assessment Tool

Table 3. List of studies that examined the repercussion of low birth weight (LBW), very low birth weight (VLBW) and excessive low birth weight (ELBW) and mortality in African continent between 2008 - 2015

Reference country	Participant characteristic: study design	Study aim	Method	Finding
Ahlsen et al. (2015) **(AHLSEN, SPONG *et al.*, 2015)** Malawi	N= 1496 Age range 5 months LBW <2500 VLBW (1000 – 1499) ELBW < 1000 Prospective descriptive study	To demonstrate the short-term survival of infants with LBW nursed in BH and KCH in Lilongwe, Malawi.	Included babies that were either admitted to the nurseries. Survival was defined as alive on discharge from the nursery or postnatal ward. Excluded were babies with severe congenital mal formations, birth weight of less than 600 g and babies with unknown outcome. The data were collected from the maternity registers, nursery admission books, duty report books and all available obstetric case records.	Survival was 7% for ELBW infants, 52% for VLBW and 90% for LBW.
Ballot et al (2015)**(BALLOT, CHIRWA *et al.*, 2015)** South Africa	N= 562 VLBW (1000 – 1499) ELBW <1000 g Retrospective cohort study	To compare morbidity and mortality in VLBW infants in 2 period, 2013 with similar data from 2006/2007.	Two similar studies with ELBW, VLBW in two period 2013 and 2006/2007 examined the survival infants.	Survival in 2013 was similar to that in 2006/2007 (73.4% vs 70.2%, p = 0.27). However, survival in neonates who weighed 750–900 g significantly improved from 20.4% in 2006/2007 to 52.4% in 2013 (p = 0.001)
Hong et al (2008)**(HONG e RUIZ-BELTRAN, 2008)** Egypt	N= 11361 Age range 5 years LBW<2500 Observational cohort study longitudinal	To examine the risk of infant mortality among LBW children controlling for other risk factors of infant mortality	The analysis uses data from the 2000 Egypt Demographic and Health Survey (EDHS). It is based on the information of 11 361 children born during the 5 years prior to the survey. The EDHS collected demographic, socioeconomic and health of mother´s child.	Higher birth order; shorter birth interval; lack of prenatal care, safe sources of drinking-water and hygienic toilet facilities; living in urban residence and upper Egypt rural region were associated with a higher risk of infant mortality. The multivariate model indicated that low-birth-weight children were about 3 times more likely to die in infancy than other children (hazard ratio = 2.89, 95% CI: 2.33–3.58) independent of other risk factors.
Rylance et al (2013)**(RYLANCE e WARD, 2013)** Malawi	N= 268 Age range 6 months VLBW and ELBW ≤ 1500 g Observational cohort study longitudinal	To study early mortality outcome in VLBW infants admitted to the neonatal nursery, Queen Elizabeth Central Hospital, Blantyre and determine duration of hospital stay of surviving infants and their attendance for recommended follow-up.	Data were extracted detailing birth weight, date of birth, sex, mode of delivery, singleton or multiple birth, estimated gestation, source of referral, maternal HIV status, antiretroviral administration for PMTCT and survival to discharge. Gestation was estimated by the SR using the Ballard score	42% (112/268) of VLBW infants survived to discharge. Survival significantly increased with increasing birth weight (11% for infants weighing ≤ 1000 g vs 53% for those >1000 g, p <0.001), and greater gestation (19% for infants ,<32 weeks vs 68% for ≥32 weeks, p<0.001). Most deaths (88%, 137/156) occurred within the first week, 58% of them (91/156) within 48 hours of admission. Surviving infants with a birth weight of 1001–1500 g stayed in hospital for a mean 21 days (range 5–44) and those weighing ≤ 1000 g at birth (eight) stayed for a mean 47 days (range 35–64). A total of 108 infants were discharged from hospital, 87 of whom (81%) attended at least one follow-up visit, 62 of whom (57%) completed the recommended follow-up attendance.

Sania et al (2014)**(SANIA, SPIEGELMAN *et al.*, 2014)** Tanzania	N=7725 LBW<2500 Age range 18 months Randomised trial	To examine the associations of neonatal and infant mortality with preterm birth and IUGR, and to estimate the pPAR% of neonatal and infant mortality due to preterm birth and IUGR.	Participants were HIV-negative pregnant women and their infants enrolled in Dar es Salaam, Tanzania. Gestational age calculated from date of last menstrual period was used to define preterm, and SG) was used as proxy for IUGR. Survival of infants was ascertained at monthly follow-up visits. Cox proportional hazard models were used to estimate the associations of preterm and SGA with neonatal and infant mortality.	Compared to term and AGA, RR of neonatal mortality among preterm-AGA was 2.6 [95% CI 1.8, 3.9], RR among term-SGA was 2.3 [95% CI 1.6, 3.3], and the highest risk was among the preterm-SGA babies (RR 15.1 [95% CI 8.2, 27.7]). Severe SGA was associated with more than fourfold higher risk of neonatal mortality 4.2 [2.8, 6.2] and SGA was associated with a doubling of neonatal mortality compared to AGA infants.

BMI - body mass index, BH – Bwaila Hospital, KCH – Kamuzu Central Hospital, CMJAH - Charlotte Maxeke Johannesburg Academic Hospital, PMTCT - Prevention of mother-to-child transmission, SR – Senior clinician, IUGR - Intrauterine growth restriction,pPAR% - partial population attributable risk per cent, AGA - appropriately sized babies, RR – relative risks

3. OBJETIVO

3. Objetivo

Avaliar a influência do baixo peso ao nascer sobre a antropometria, composição corporal, aptidão física e coordenação motora, em crianças moçambicanas de idade entre 7 – 10 anos residentes na cidade de Maputo

4. HIPÓTESES

4. Hipóteses

H0- O baixo peso ao nascer pode influenciar o crescimento físico (peso, estatura e IMC), a composição corporal (% de gordura, massa gorda e massa magra) e a aptidão física e coordenação motora durante a infância

H1- O peso ao nascer é um preditor da força muscular, velocidade de corrida durante a infância independente dos efeitos cumulativos do tamanho do corpo e composição corporal e não interfere a coordenação motora.

5. MÉTODOS

5. Métodos

5.1 Local de estudo

O presente estudo foi realizado na cidade de Maputo entre os meses de Junho e Dezembro de 2014. Maputo é a capital e a maior cidade de Moçambique. É também o principal centro financeiro, corporativo e mercantil do país. Localiza-se na margem ocidental da Baía de Maputo, no extremo sul do país, perto da fronteira com a África do Sul e, da fronteira com a Suazilândia e, por conseguinte, da tripla fronteira dos três países. Até 13 de março de 1976 a cidade era denominada "Lourenço Marques" em homenagem ao explorador português homônimo. A cidade tem uma área de 346,77 km², segundo o censo realizado em 2007, a cidade de Maputo é habitada por cerca de 1 094 315 habitantes e conta com cerca de 150 escolas primárias. Na cidade de Maputo a prevalência de baixo peso é de 10,8% (INSTITUTO NACIONAL, 2011). De todos os países lusófonos analisados o Índice de Desenvolvimento Humano (IDH) em Moçambique é de 0,41 por cento apesar de ter registado uma franca melhoria desde as últimas duas décadas. Moçambique está na posição 180 num conjunto de 188 países analisados. Produto Interno Bruto em Moçambique (PIB), em 2014 foi de 17,1 bilhão de dólares.

Figura. 1 Mapa ilustrativo da configuração geográfica da cidade de Maputo

5.2 Amostra

Este estudo de delineamento transversal teve como amostra um grupo de crianças (ambos os gêneros) compreendidas entre 7 e 10 anos idade, subdivididas de acordo com o peso ao nascer. Os grupos foram formados a partir do peso ao nascimento em baixo peso ao nascer (BPN: >1.000 g e ≤ 2.500g, n = 155) e o grupo peso normal (PN: > 3.000g, n= 198). A amostra foi calculada utilizando-se técnicas estatísticas de acordo com as normas científicas com margem de erro de ± 5% e o grau de confiança de 95% e p < 0,05.

O peso ao nascer foi obtido a partir do cartão do peso da criança quando nasceu. Para a criança fazer parte das avaliações, foram enviados termos de consentimento (Anexos) com um texto explicativo sobre o projeto de pesquisa e somente os alunos que apresentaram as fichas assinadas pelos pais ou responsáveis poderiam participar. No
termo de consentimento, os pais deveriam informar o peso ao nascer das crianças e esse documento serviu como critério de inclusão. O presente estudo foi aprovado pelo Comité Nacional de Bioética para a Saúde de Moçambique. **Ref.48/CNBS/2014** (Anexos).

5.3 Antropometria e composição corporal

A avaliação dos parâmetros antropométricos das crianças incluiu: **peso corporal**: obtido utilizando-se uma balança de plataforma com capacidade máxima de 150 Kg e precisão de 100g (Filizola, São Paulo, Brasil). O avaliado posicionou-se em pé, de costas para escala de medidas da balança, em posição ortostática, levemente vestido (calção e camisa) (LOHMAN, 1986). **Altura**: foi medida entre o plano de referência do solo e o vértex, com o individuo descalço, utilizando-se para esta medida um estadiômetro portátil com precisão de 0,1 cm (Sanny, São Paulo, Brasil).

Para avaliação da **composição corporal** das crianças foram utilizadas as medidas das dobras de adiposidade subcutânea. Essa técnica consiste em destacar uma camada de pele e gordura, de forma que exclua o músculo subjacente. Para obtenção dos valores de dobra cutânea, foi utilizado um adipômetro de marca Lange, de precisão de 0,1mm (Lange, Santa Cruz, Califórnia). O calibrador exerce uma pressão constante de 10 g/mm2, e precisão de 1 mm. Todas as mensurações foram realizadas no hemicorpo direito do avaliado na região tricipital, bicipital, subescapular, supra-ilíaco, abdominal e geminal e repetida duas vezes em cada local em todos os alunos analisados, ocorrendo uma terceira medição sempre que a diferença entre a primeira e a segunda medição exceder 5%. No final, foi extraída a média aritmética entre os dois valores mais próximos obtidos. Todo o protocolo de medição foi realizado segundo padronização sugerida por Lohman, (1986).

Indicadores do estado nutricional.

A avaliação do crescimento é a medida que melhor define a saúde e o estado nutricional de crianças, já que distúrbios na saúde e nutrição, independentemente de suas etiologias, invariavelmente afetam o crescimento infantil (SIGULEM, DEVINCENZI *et al.*, 2000). Nos países em desenvolvimento, a maioria dos problemas de saúde e nutrição durante a infância está relacionada com consumo alimentar inadequado e infecções de repetição, sendo que essas duas condições estão intimamente relacionadas com o padrão de vida da população, que inclui o acesso a alimentação, moradia e assitência à saúde. Dessa forma, então, a avaliação do crescimento infantil é também uma medida indireta da qualidade de vida da população (SIGULEM, DEVINCENZI *et al.*, 2000). Para a avaliaçao do estado nutricional neste estudo foram utilizados os índices: Peso/idade, altura/idade, peso/altura

5.3.1 Perímetro do braço relaxado

Fornece o índice de depósito de gordura e de massa muscular local. O avaliado em pé, na posição ereta, braços ao longo do corpo e palmas das mãos voltadas para a coxa e o avaliador fica do lado do avaliado. Localiza-se o ponto de referência anatômica pedindo ao avaliado que flexione o cúbito a 90º com a palma da mão voltada para cima. Calcula-se então a distância absoluta entre os pontos de referência anatômica e marca–se o ponto central com o lápis demográfico. Envolvendo o braço com a fita, de forma que esta aloje sobre o ponto marcado, faz–se a medida. Serão efetuadas duas medidas e o resultado será à média entre as duas.

5.3.2 Perímetro da cintura

Fornece parâmetros para avaliar as variações na distribuição da gordura corporal, realiza-se na região abdominal, em seu menor perímetro. O avaliado fica na posição ortostática e o avaliador de frente para o avaliado. Passa-se a fita em torno do avaliado de trás para frente, tendo-se o cuidado de manter a mesma no plano horizontal. A seguir faz-se a leitura, após o avaliado realizar uma expiração normal. Serão efetuadas duas medidas e o resultado foi média entre as duas.

5.3.3 Perímetro geminal

Serve como indicador de adiposidade em adultos e de desenvolvimento muscular. Realiza-se na região da panturrilha, em sua maior porção. O avaliado fica sentado, com o apoio dos pés no chão e o avaliador fica agachado, do lado direito do avaliado. Verifica-se a região correspondente ao maior perímetro da panturrilha movendo-se a fita métrica em torno da perna e ao longo desta. Faz-se a leitura da medida tendo o cuidado de manter a fita métrica paralela ao chão.

5.3.4 Cálculo de indicadores de composição corporal

A partir das medidas antropométricas foram realizados os seguintes cálculos para estimar: categoria ponderal (IMC), e o % de gordura corporal, massa corporal magra, massa gorda:

Índice de Massa Corporal (IMC) =massa corporal (Kg)/estatura (m^2)

Para o cálculo da percentagem corporal foi usado a equação de Slaughter e colegas (SLAUGHTER, LOHMAN *et al.*, 1988a).

Para meninos: percentagem de gordura = 0.735 (tric+gem) + 1.0

Para meninas: percentagem de gordura = 0.610 (tric+bem) + 5.1

A partir dos valores do percentual de gordura corporal, foram calculados os valores de **massa gorda** (MG) e **massa magra** (MM).

MG (kg) = massa corporal (kg) x % gordura corporal/100

MM (kg)= massa corporal (kg) – massa gorda

5.4 Avaliação da Aptidão física (AptFS)

Os dados da aptidão física foram coletados mediante a administração de uma bateria de testes motores compostas por cinco itens conhecidos e padronizados, obedecendo à seguinte seqüência: força de preensão (dinamometria), flexibilidade (sentar e alcançar), força e resistência abdominal (curl-up´s), força explosiva de membros inferiores (impulsão horizontal), corrida de velocidade (corrida 20m) e cuja estrutura está descrita na Tabela 2. Toda a avaliação da aptidão física foi efetuada com base nos protocolos das baterias de testes *FITNESSGRAM e EUROFIT* (Anexos).

Tabela 2. Estrutura da bateria de testes

Testes	**Componentes de Aptidão Física**
Força de Preensão (kg/f)	Força Isométrica
Impulsão Horizontal (cm)	Força Explosiva de Membros Inferiores
Teste Corrida de 20 metros (m/s)	Velocidade
Teste Sentar e Alcançar (cm)	Flexibilidade
Resistência Abdominal (r/mim.)	Força /Resistência Muscular Abdominal

Kg/f: kilograma força; cm: centímetros; m/s: metros por segundo; m/mim: metros por minuto.

5.4.1 Força de Preensão

Para a realização do teste de força de preensão, o participante ficou posicionado de pé, com o braço estendido ao longo do corpo (posição anatômica), com o dinamômetro posicionado em uma das mãos (direita ou esquerda), ao ser informado o avaliado realizou uma força máxima durante 5 segundos. O avaliador registrou o valor na ficha de coletas e em seguida o participante passou o dinamômetro para a outra mão, repetindo todo o procedimento anterior. O teste foi realizado com duas medições em cada mão com intervalo de um minuto entre elas, sendo utilizado para a análise dos dados apenas o maior desempenho em termos absolutos (SAFRIT, STAMM *et al.*, 1977) Figura 2.

Figura 2: avaliação da força de preensão

5.4.2 Teste de força explosiva de membros inferiores (salto horizontal)

Para a avaliação da força dos membros inferiores através do salto horizontal utilizou-se uma trena fixada ao solo, perpendicularmente à linha demarcatória inicial, ficando o ponto zero sobre a mesma. A criança colocou-se imediatamente atrás da linha, com os pés paralelos, ligeiramente afastados, joelhos semiflexionados e tronco ligeiramente projetado à frente. Ao sinal, a criança saltou uma maior distância possível. Foram realizadas duas tentativas, registrando-se o melhor desempenho. A distância do salto foi registrada em centímetros a partir da linha inicial traçada no solo até o calcanhar mais próximo desta (SAFRIT, STAMM *et al.*, 1977).

5.4.3 Teste de Flexibilidade (Sentar-e-alcançar)

Para avaliação da flexibilidade utilizou-se o Banco de *Wells* com as seguintes características: um cubo construído com peças de 30 x 30 cm; uma escala de 50 cm de comprimento por 15 cm de largura; graduação com trena métrica entre 0 a 50 cm. Na aplicação deste teste, as crianças estavam descalças. O avaliado senta-se de frente para a base da caixa, com as pernas estendidas e unidas. Com as mãos sobrepostas elevam os braços na vertical, inclinam o corpo para frente e alcançam com as pontas dos dedos das mãos tão longe quanto possível sobre a régua graduada, sem flexionar os joelhos e sem utilizar movimentos de balanço (insistências). Cada aluno realizou duas tentativas. O avaliador permaneceu ao lado do aluno, para assegurar que os joelhos permanecessem em extensão. O resultado foi obtido a partir da posição mais longínqua que o aluno pôde alcançar na escala com as pontas dos dedos. Registrou-se o melhor desempenho entre as duas execuções (SAFRIT, STAMM *et al.*, 1977) Figura 3.

Figura 3. Avaliação da flexibilidade

5.4.4 Teste de resistência abdominal - Curl up

Executante em decúbito dorsal sobre o tapete. Os joelhos fletidos a 90º, pés ligeiramente afastados e apoiados no solo. Os braços e as mãos mantidas em extensão ao lado, com as palmas em contacto com o tapete tocando um extremo da faixa que está colocada ao lado do executante. O executante elevou o tronco até tocar com os dedos o outro extremo da faixa. As repetições são executadas a uma cadência de 1 a cada 3 seg. A criança executa as repetições até à exaustão ou até a um máximo de 75. É registado o número de elevações realizadas corretamente (SAFRIT, STAMM *et al.*, 1977).

Figura 4. Teste de Curl up (resistência abdominal)

5.4.5 Teste de velocidade de deslocamento (corrida de 20 metros)

Para administração deste teste é necessário: um cronômetro e uma pista de 20 metros demarcada com três linhas paralelas no solo da seguinte forma: a primeira (linha de partida); a segunda, distante 20m da primeira (linha de cronometragem ou linha de chegada) e a terceira linha (linha de referência), marcada a dois metros da segunda (linha de chegada). A terceira linha serve como referência de chegada para o aluno na tentativa de evitar que ele inicie a desaceleração antes de cruzar a linha de cronometragem. Dois cones para a sinalização da primeira e terceira linhas. O estudante parte da posição de pé, com um pé avançado a frente imediatamente atrás da primeira linha e será informado que deverá cruzar a terceira linha o mais rápido possível. Ao sinal do avaliador, o aluno deverá se deslocar, o mais rápido possível, em direção à linha de chegada. O avaliador aciona o cronômetro no momento em que o avaliado der o primeiro passo (tocar ao solo), ultrapassando a linha de partida. Quando o aluno cruzar a segunda linha (dos 20 metros) será interrompido o cronômetro (SAFRIT, STAMM *et al.*, 1977)

5.5 Avaliação do desempenho neuromotor

Para a avaliação do Desenvolvimento neuro motor (DNM) foi utilizada a bateria de testes de coordenação corporal e desempenho motor através do Körperkoordinations-test für Kinder (KTK), proposto por Kiphard e Schilling (1974). O teste KTK tem em sua composição a realização de quatro tarefas de movimentos: equilíbrio em marcha à retaguarda, saltos monopedais, saltos laterais e transferência sobre plataformas, cuja estrutura esta descrita na (Tabela 5)

Tabela 3 – Estrutura do teste Körperkoordinations-test für Kinder (KTK)

Testes	**Componentes do Desempenho Motor**
Trave de Equilíbrio	Estabilidade do equilíbrio em marcha à retaguarda sobre a trave
Saltos monopedais	Coordenação dos membros inferiores; energia dinâmica/força.
Saltos Laterais	Velocidade em saltos alternados
Transferência sobre plataformas	Lateralidade; estruturação espaço-temporal

5.5.1 Trave de Equilíbrio

São utilizadas três traves de 3 metros de comprimento e 3 cm de altura, com larguras de 6 cm, 4,5 cm e 3 cm. Como superfície de apoio para saída, coloca-se à frente da trave, uma plataforma medindo 25 x 25 x 5cm. As três traves de equilíbrio são colocadas paralelamente. A tarefa consiste em caminhar à retaguarda sobre três traves de madeira com espessuras diferentes. São válidas três tentativas em cada trave. Durante o deslocamento (passos) não é permitido tocar o solo. Antes das tentativas válidas, o sujeito terá um pré-exercício para se adaptar à trave, no qual realiza um deslocamento à frente e outro à retaguarda (Figura 5). Para cada trave, são contabilizadas três tentativas válidas, o que perfaz um total de nove tentativas. O resultado será igual ao somatório de execuções a retaguarda nas 9 tentativas.

Figura. 5 Trave de equilíbrio

5.5.2 Salto Monopedal

São usados 12 blocos de espuma, medindo 50 x 20 x 5 cm cada um. A tarefa consiste em saltar um ou mais blocos de espuma colocados uns sobre os outros, com uma das pernas. A altura inicial a ser contada baseia-se no resultado do exercício-ensaio e na idade do indivíduo. Com isso, devem ser alcançados mais ou menos os mesmos números de passagens a serem executadas pelos avaliados nas diferentes faixas etárias. Estão previstos dois exercícios-ensaio para cada perna (direita e esquerda).

Figura. 6 Salto monopedal

5.5.3 Salto Lateral

Uma plataforma de madeira (compensado) de 60 x 50 x 0,8 cm, com um sarrafo divisório de 60 x 4 x 2 cm e um cronômetro. A tarefa consiste em saltitar de um lado a outro, com os dois pés ao mesmo tempo, o mais rápido possível, durante 15 segundos. Deve ser evitada a passagem alternada dos pés (um depois do outro). Registram-se o número de saltos dados, em duas passagens de 15 segundos (saltitando para um lado, conta-se 1 ponto; voltando, conta-se outro, e assim sucessivamente). Como resultado final da tarefa teremos o somatório de saltos das duas passagens válidas (Figura 7).

Figura. 7 Salto lateral

5.5.4 Transferência sobre Plataforma

São usados para o teste, duas plataformas de 25 x 25 x 5 cm e um cronômetro. As plataformas são colocadas lado a lado com uma distância entre elas de 5 cm. Na direção de deslocar é necessário uma área livre de 5 a 6 metros. A tarefa consiste em deslocar-se sobre as plataformas que estão colocadas no solo, em paralelo, uma ao lado da outra. O tempo de duração será de 20 segundos, e a criança terá duas tentativas para a realização da tarefa. A transferência lateral pode ser feita para a direita ou para a esquerda, de acordo com a preferência do indivíduo. No caso de haver apoio das mãos, toque de pés no chão, queda ou quando a plataforma for pega apenas com uma das mãos, o avaliador deve instruir o aluno a continuar e, se necessário, fazer uma rápida correção verbal, sem interromper a tarefa. São executadas duas passagens de 20 segundos, devendo ser mantido um intervalo de pelo menos 10 segundos entre elas (Figura 8). Conta-se tanto o número de transferências das plataformas, como também as do corpo, em um tempo de 20 segundos. Anotam-se os valores da primeira e segunda tentativa válida, em seguida, somam-se esses valores, obtendo-se o valor bruto da tarefa

Figura. 8 transferêrencia sobre a plataforma

5.6 Processamento e analise estatística

Para a análise estatística, utilizou-se o software SPSS for Windows, versão 20.0. Inicialmente, foi realizada uma análise exploratória dos dados para identificar a eventual presença de informações incorretas ou inconsistentes (*outliers*), bem como testar a hipótese de normalidade em todas as distribuições de dados (Kolmogorov-Smirnov). As variáveis com distribuição heterogênea foram ajustadas por meio de transformação logarítmica. A interação entre os fatores sexo e idade com o peso ao nascer foram avaliadas por ANOVA *Two-way* (ou seja: sexo *vs* peso ao nascer e idade *vs* peso ao nascer). Como não foram encontradas interações significativas, os dados foram analisados como um único grupo (ou seja: meninos e meninas juntos).

Após estes procedimentos comuns às duas análises no artigo original: para analisar as diferenças entre os grupos BPN e PN foi utilizado o *t-test Student* para amostras independentes. Os valores são apresentados como média ± desvio padrão. Em seguida os resultados foram ajustados para diferentes covariáveis: idade, sexo, altura, peso corporal, IMC, composição corporal (massa corporal magra e massa gorda) e nível de atividade física através da análise de covariância (ANCOVA). Em todas as análises o nível de significância de 5% foi utilizado.

6. RESULTADOS

6. Resultados – artigo original

Os resultados deste estudo estão apresentados sob a forma de um artigo original que será divulgado em veículo científico conforme regulamentação do Colegiado de Pós-Graduação do Centro de Ciências da Saúde da UFPE.

O artigo: intitulado *"Persistent deficits in anthropometric indices of nutritional status and motor performance in low birth weight children from Maputo city, Mozambique"* foi submetido na revista Developmental Medicine and Child Neurology

Title: Persistent deficits in anthropometric indices of nutritional status and motor performance in low birth weight children from Maputo city, Mozambique

Running Headline: Low birth weight and growth

Abstract

Aim: To evaluate the influence of the low birth weight (LBW) on anthropometry, body composition, physical fitness and gross motor coordination of school children aged 7-10 from Maputo, Mozambique. **Method**: A total of 353 children aged 7 to 10 years old from both gender born in Maputo (Mozambique) were sampled. The sample was divided into two groups: LBW (n=155) and normal birth weight (NBW, n=198). Body composition measurements and the indices weight-for-age, height-for-age and weight-for-height were assessed. Physical fitness was assessed by handgrip strength, flexibility, agility, long jump and running speed. Gross motor coordination was evaluated by using the Korper Koordination Test fur Kinder (KTK) battery. **Results:** LBW children were lighter and smaller than NBW with reduced indices weight-for-age and height-for-age. They also showed a reduced performance in handgrip strength and sideway movements tests. These differences remained significant even after adjusted for age, gender, body size and fatness skinfold thickness. **Interpretation:** LBW seems to be the major factor that influences anthropometry and it is a predictor for the performance of muscle strength and sideway movements tests. This result suggests that growth faltering may occur independently of gender, age, fatness and body size.

What this paper adds:

- Birth weight influences indicators of nutritional status independently of gender and age
- Birth weight is a predictor of muscle strength and sideway movements.
- Body size and fatness influence the performance in motor coordinator tests in children
- Birth weight influence growth independently of gender, age, fatness and body size

Keywords: Birth weight, stunting, Mozambique, children, motor coordination

There are substantial evidences from epidemiological, clinical and experimental studies that fetal and early post- natal environmental stimuli can invoke physiological adaptations in the organism during development (ASHTON, 2000; WELLS, 2007; ANTONY e LAXMAIAH, 2008; DE BRITO ALVES, NOGUEIRA *et al.*, 2014; ALHEIROS-LIRA, ARAUJO *et al.*, 2015). Early exposure to environmental changes during gestation and lactation (nutritional deprivation, drugs, maternal stress, smoke, alcohol, etc) can lead to long-term consequences to health (WELLS, 2007). This phenomenon can be understood in the context of the "thrifty phenotype hypothesis" as suggested by Hales and Barker (HALES e BARKER, 1992). Experimental evidences have shown that perinatal malnutrition (low protein/caloric diet during gestation and lactation) is related to hypertension, dyslipidemia, hyperinsulinemia and glucose intolerance in adult offspring (DE BRITO ALVES, NOGUEIRA *et al.*, 2014; DO NASCIMENTO, DE SANTANA MUNIZ *et al.*, 2014). In human, low birth weight children (LBW; birth weight below than 2,500 grams irrespective of gestational age) present excessive gain of body weight (catch up growth) and fat accumulation during childhood, hypertension and obesity during early adult life (CONDE e MONTEIRO, 2014; PARRA, IANNOTTI *et al.*, 2015). Previous studies showed that LBW children remain significantly shorter and lighter, present an adverse physical and cognitive development, reduced lean body mass, increased and accumulation of fat mass when compared to normal birth weight (NBW) children (HEMACHANDRA, KLEBANOFF *et al.*, 2006; WELLS, 2007; VICTORA, ADAIR *et al.*, 2008). Weight was also considered an important determinant of the variance of neuromotor development in children (DA SILVA, MONTEIRO GALINDO *et al.*, 2014) and an inducer of permanent deficits in muscle strength and running speed performance (MOURA-DOS-SANTOS, WELLINGTON-BARROS *et al.*, 2013; MOURA-DOS-SANTOS, DE ALMEIDA *et al.*, 2015). These changes represent risks for health outcomes such as coronary heart disease, stroke, type 2 diabetes, and the metabolic syndrome, all of which have been shown to be increased in under-developing and developing countries (VICTORA, ADAIR *et al.*, 2008).

Africa is a continent with a high prevalence of children born with low birth weight, particularly sub-Saharan Africa (NAMIIRO, MUGALU *et al.*, 2012). It is estimated that in sub-Saharan Africa, LBW represents 14.3% that is almost twice of the rate of European countries (NAMIIRO, MUGALU *et al.*, 2012). In African countries, previous studies have shown the effects of birth weight on growth and development during childhood (KIMANI-MURAGE, 2013). In Keneba, the Gambia, birth weight have been inversely associated with impaired adult bone strength, in a sample of both gender aged 7 to 21 years (DE BONO, SCHOENMAKERS *et al.*, 2010). Birth weight was also inversely related to systolic blood pressure in childhood in Zimbabwe and in South Africa (LEVITT, LAMBERT *et al.*, 2000). In Congo, the rates of LBW children were 164 per 1000 alive births in Kama, and 270 per 1000 in Kipaka (MILABYO KYAMUSUGULWA, 2006). In Jimma, southwestern of Ethiopia, this prevalence was 22.5% (TEMA, 2006). In Zimbabwe, a study found a prevalence of 12.9% of LBW children (TICCONI, ARPINO *et al.*, 2005). In Mozambique, the prevalence of LBW infants was 14% according to the Ministry of Health Research (SAÚDE, 2013), but there is no investigation about the short and long term effects of the low birth weight.

Mozambique has experienced significant economic growth over the last 20 years following the end of the Civil War. However, the main concern of the economic and technological development, as seen in this country, is the adoption of westernized life style, fast food intake and low levels of physical activity. A recent study showed that Mozambican adolescents presented reduction of physical activity levels, especially in the capital city of Maputo (DOS SANTOS, MAIA, GOMES, DACA, MADEIRA, KATZMARZYK *et al.*, 2014). Indeed, urban areas in Mozambique are declining in active habits and opportunities for physical activity due largely to fast urbanization (PRISTA, PICARDO *et al.*, 2014). Previous studies have shown a negative secular trend in habitual physical activity and physical fitness among Mozambican youth (DOS SANTOS, MAIA, GOMES, DACA, MADEIRA, DAMASCENO *et al.*, 2014; DOS SANTOS, PRISTA *et al.*, 2015). Among the risk factors underlying the high incidence of infant obesity and physical inactivity in Mozambique, little is known about the association among current characteristic of growth, habitual physical activity, physical fitness and neuromotor development with the early events during perinatal life, such as birth weight.

In the present study, school children (7 to 10 years old) belonging to distinct birth weight groups (LBW and NBW) were evaluated to verify if there are significant mean differences in their attained somatic growth, body composition, anthropometric nutritional status, physical fitness and neuromotor development. In addition, comparisons were adjusted for chronological age, gender, body size and body fat. Analysis were carried out to test the hypothesis that birth weight increases the body weight gain, reduced the performance in physical fitness and motor coordination tests independently of chronological age, gender and body composition variables.

METHODS

Ethics Statement

This study was approved by the Ethics committee of the Ministry of Health – Mozambique, number [48/CNBS/2014] in accordance with the ethical standards of the 1964 Helsinki Declaration. Written informed consent from parents or legal guardians was a criterion for the inclusion of each child in the study. Birth weights were obtained from health booklets in which this information was recorded by nurses and/or pediatricians. All study procedures were took place at schools.

Participants

This study was conducted in Maputo, capital and the largest city of Mozambique where prevalence of low birth weight children is around 11% (SAÚDE, 2013).The sample size was estimated in Epi Info 6.04 given the following conditions: an error of ±5%, a power of 80%, and a relative risk of 2.0 for events in low-birth weight versus normal birth weight subjects, i.e., a ratio of 2:1. A total of three hundred fifty-three 7 to 10 years old children from both gender participated in this study. The sample was divided into two groups according to their birth weight: LBW from 1.500 g to 2.500 g (n=155) and normal birth weight (NBW) from 3.000 g to 3.999 g (n=198). All measurements were carried out during a 10-month period from March to December 2014, according to the school calendar. We did not record information about gestational age or maternal nutritional condition during gestation and lactation.

Prior to data collection, all children participated in one introductory session and research assistants demonstrated proper testing procedures for each test. Children were asked do not to perform any vigorous physical activity on the day before of the tests.

Anthropometry and body composition

Body height and sitting height were measured to the nearest 1.0 cm using a portable stadiometer (Holtain, Crymych, United Kingdom) with the participant's head positioned in the Frankfurt horizontal plane (LOHMAN, 1986). The body weight of the lightly dressed and bare footed subjects was measured to the nearest 0.1 kg with a digital scale (Secca, Germany). Body mass index (BMI) was calculated using the standard formula [weight (kg)/height^2 (m)]. Triceps, biceps, subscapular, suprailiac, abdominal and geminal skinfolds were measured with a Langercaliper (Lange, Santa Cruz, California, USA). Body fat percentage, fat mass (Kg) and fat free mass (Kg) were estimated using the formulas described in previous studies

(SLAUGHTER, LOHMAN *et al.*, 1988b; LOHMAN e GOING, 2006). All measurements were done according to the procedures outlined in previous study (SLAUGHTER, LOHMAN *et al.*, 1988b).

Anthropometric indicators of nutritional status were analyzed by the indices weight-for-age, height-for-age and weight-for-height (WHO, 2008). Arm, leg and waist circumferences were measured according to previous study procedures by using metal anthropometric tape in the midway between the lower margin and higher margin (WHO, 2008).

Physical fitness

Physical fitness was assessed with well five known standardized tests including: (1) handgrip strength (measured independently in each hand) by using a handgrip dynamometer (Saehan, Flintvile, USA); (2) standing long jump (expressing the explosive power of lower limbs); (3) curl-ups (as an indicator of dynamic muscle endurance); (4) "sit and reach" as a measure of flexibility; (5) 20-meter run to measure running speed (MOURA-DOS-SANTOS, WELLINGTON-BARROS *et al.*, 2013).

Gross motor coordination

Gross motor coordination was evaluated with a standardized test battery for children which was developed in Germany (*Körper Koordination Test für Kinder* - KTK) (KIPHARD e SCHILLING, 1974), and has been widely used in Brazil [14]. The KTK includes the assessment of the following items: (1) balance – child walks backward on a balance beam 3 m in length, but of decreasing widths: 6 cm, 4.5 cm, 3 cm; (2) jumping laterally – child makes consecutive jumps from side to side over a small beam (60 cm×4cm×2 cm) as fast as possible for 15 s; (3) hopping on one leg over an obstacle – the child is instructed to hop on one foot at a time over a stack of foam squares. After a successful hop with each foot, the height is increased by adding a square (50 cm×20 cm×5 cm) and (4) shifting platforms – child begins by standing with both feet on one platform (25 cm×25 cm×2 cm supported on four legs 3.7 cm high); places the second platform along-side the first and steps on to it; the first platform is then placed alongside the second and the child steps on to it; the sequence continues for 20 s. For each task, performance was scored in a point system as suggested by the protocol, and then were summed and converted in the overall motor quotient (MQ), which is gender and age specific. The overall MQ qualifies gross motor development in the following categories: 'not possible' (MQ<56), 'severe motor disorder' (MQ 56–70), 'moderate motor disorder' (MQ 71–85), 'normal' (MQ 86–115), 'good' (MQ 116–130) and 'high' (MQ131–145) [14].

Statistical analysis

Assessment of normality of sample was performed by using Kolmogorov-Smirnov test. Exploratory analysis was used to identify possible inaccurate information and the presence of outliers. Variables with skewed distributions were log-transformed. Descriptive statistics are presented as means with standard deviations. Interaction factors between sex and age with birth weight were assessed by 2-way ANOVA (i.e., sex x birth weight and age x birth weight). Because no statistically significant interactions were found, data were analyzed as a single group (i.e., boys and girls together). The differences between LBW and NBW children were examined with independent *t*-tests. For the variables that showed significant difference between LBW and NBW, an analysis of covariance (ANCOVA) was performed to control the influence of chronological age, gender, body size and fatness skinfold. It was used dimension reduction for one factor since some variables were strongly correlated ($r^2 > 0.75$): 1) **Body size** included body weight, height, fat free mass, fat mass, sitting height and spam acromion; 2) **Fatness skinfold thickness (FST)** included: triceps, biceps, subscapular, suprailiac, abdominal and geminal skinfolds. SPSS 19.0 was used in all analyzes, and the level of significance was set at 5%.

RESULTS

Descriptive information regarding anthropometry, body composition, anthropometric indicators of nutritional status, physical fitness and gross motor coordination is shown in Table 1. The LBW group showed a lower body weight and height, BMI and fat free mass than NBW group. LBW also showed reduced index weight-for-age and height-for-age, as well as the circumferences of arms and legs. For physical fitness, LBW group showed a reduced performance in handgrip test strength. For indicators of motor coordination, LBW group showed a better performance in balancing backwards test, but a lower performance in sideway movements than NBW group (Table 1).

Table 2 presents the adjusted means after controlling for different covariates. The differences in fat-free mass disappeared when the mean value was adjusted for gender, age, height sitting height and FST (p=0.466). Similarly, differences in circumference of arms and legs were no longer significant when the predictors were adjusted for body size, gender and FST. Body weight, height, BMI, weight-for-age and height-for-age remained significant even after controlling for age, gender, body size and FST. Likewise, the differences in right and left handgrip strength (p=0.038 and p=0.011, respectively) and sideway movements (p=0.003) remained significant even after controlling for age, gender, body size and FST (Table 2).

DISCUSSION

In the present study, although LBW children were smaller, lighter and have less fat-free mass than NBW children, both groups showed height and weight values within the normal range of the WHO international growth references (WORLD HEALTH

ORGANIZATION, 2004), as well as within the normal range of children from the some countries of sub-Saharan Africa (NAMIIRO, MUGALU *et al.*, 2012). In children, the three most commonly used anthropometric indices to assess their growth status are weight-for-height, height-for-age and weight-for-age (WORLD HEALTH ORGANIZATION, 2004). In the present study, LBW children showed both low height-for-age (stunted growth) and weight-for-age (wasted growth) when compared to NBW children. Stunted growth (low height-for-age) reflects a process of failure to reach potential linear growth potential as a result of suboptimal health and/or nutritional conditions (WORLD HEALTH ORGANIZATION, 2004). Our findings corroborate previous studies with African children (from Congo, South Africa and Uganda) that showed significant associations between LBW and low values of growth indicators (NJOKANMA, EGRI-OKWAJI *et al.*, 2008; MACKAY, BALLOT *et al.*, 2011; NAMIIRO, MUGALU *et al.*, 2012). High levels of stunting are associated with poor socioeconomic conditions and increased risk of illness and/or inappropriate feeding practices (WORLD HEALTH ORGANIZATION, 2004). A recent study found a co-existence of substantial levels of stunting at an early age, with marked levels of overweight/obesity and an elevated risk for metabolic disease in adolescent girls (KIMANI-MURAGE, 2013).

Understanding the relationship between birth weight and a wider range of children anthropometric characteristics, including sitting lengths, skinfolds, body circumferences and spam acromion may offer novel insight into variation in the proportionality of infant growth across the birth weight spectrum. In the present study LBW children also presented a low BMI, fat-free mass, weight-for-age and reduced circumference of arms and legs when compared with NBW children. The index weight-for-age fails to distinguish differences across groups because of the variation of body composition (such as relative contribution of adiposity). Indeed, we observed that there were no differences in all fatness skinfold thickness between groups. In the present study, we found that the LBW children showed a lower BMI and FFM than NBW, which corroborate previous studies (CHOMTHO, WELLS *et al.*, 2008; SCHELLONG, SCHULZ *et al.*, 2012; MOURA-DOS-SANTOS, WELLINGTON-BARROS *et al.*, 2013). In Keneba, the Gambia, birth weight have been inversely associated with impaired adult bone strength, male and female 7 to 21 years (DE BONO, SCHOENMAKERS *et al.*, 2010). A recent study showed that LBW influenced negatively the body weight and fat free mass in young men (19 to 21 years old) from Maputo city, Mozambique (TCHAMO, DOS-SANTOS *et al.*, 2016). Deprived early growth combined with high food consumption and inactive life style during childhood and an obesogenic adult environment are the main concerns of low-middle income countries where exist the transitions to westernized lifestyles and the risk of low birth weight (WELLS, 2012).

The association between LBW and risk of disturb during growth and development in childhood is considered the most consistent evidence supporting the thrifty phenotype hypothesis proposed by Hales and Barker (HALES e BARKER, 1992). There are plausible evidences that suggest that the perinatal disturbs as low birth weight present a non-deterministic effect during childhood and adulthood (WELLS, 2010; WELLS e STOCK, 2011), and different events that occur during infancy and childhood adjusted by gender and age can influence significantly the power of this association (ROONEY, MATHIASON *et al.*, 2011). Herein, after to adjust predictors for gender, age, body size and fatness skinfold thickness, we demonstrated that the short-term effects of LBW remained for body weight, height, BMI and anthropometric indicators of nutritional status. In contrast, a previous study with Brazilian children (aged 7 to 10) showed that the differences between these variables disappeared after the adjustment for chronological age, gender, physical activity levels and attained body size (MOURA-DOS-SANTOS, WELLINGTON-BARROS *et al.*, 2013). A longitudinal study of eight cohorts of children in four countries – Ethiopia, India, Peru, and

Vietnam showed that even among children who changed their living standards, the influence of early environment of deprivation have lasting influences through infancy, childhood, and adolescence in all four countries (KRISHNA, OH *et al.*, 2015). Thus, the influences of early life on older children, who are beyond the critical period of infancy and childhood, suggest that growth faltering may occur among older children and that is independently of gender, age and body size. One explanation for the persistence low body weight and height during childhood is that the association between LBW and stunting in older children is confounded by persistent poverty from birth as seen in Mozambique.

Our findings showed that LBW children presented a low performance on handgrip strength test and sideway movements even after to adjust for body size, fatness skinfold thickness, gender and age. This result is supported by previous studies where low birth weight children presented reduced motor performance including muscle strength and muscle endurance (RIDGWAY, BRAGE *et al.*, 2011). Indeed, muscular strength and some variables of motor coordination are negatively influenced by low birth weight and stunted children (9 years ± 6 months) presented lower capacities to develop muscle strength under voluntary or induced conditions (PAIVA, SOUZA *et al.*, 2012; MOURA-DOS-SANTOS, WELLINGTON-BARROS *et al.*, 2013). For our surprise, LBW children presented a better performance in balancing backwards test. This test is based on the premise that the integration among proprioception, vestibular function and vision is necessary to maintain the body's sense in movement which requires perfect functioning of the cerebellum, spinal cord and skeletal muscle innervation (ACHIRON e KALRON, 2008). The covariates body size (weight, height, fat free mass, fat mass, sitting height and spam acromion), fatness skinfold thickness, gender and age can influence the performance in the balancing backwards test. Indeed, when this variable was controlled by covariates, the difference between LBW and NBW was no longer evident.

The limitations of the present study are the lack of information about the period of gestational age and lactation that could also influence the body composition and motor performance outcomes of children. Physical activity is also an important variable that could be analysed in order to better understand the current effects of the environment.

CONCLUSION

In children from Maputo - Mozambique, LBW seems to be a major factor that influences anthropometry, but not physical fitness and neuromotor components. For physical fitness and motor coordination, LBW is a strong predictor only in the performance in muscle strength and sideway movements tests during childhood. Thus, for this population, the influences of early life is strong for children during development suggesting that growth faltering may occur independently of gender, age, fatness and body size. The association between LBW and stunting/wasted may explain our findings. This suggests that poor living standards at ages seven to ten years old do not induce a catch up of growth in children. There is concern that the influence of LBW is combined (matched) with prolonged experiences of poverty over their life-course.

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Table 1 - Means and standard deviations of anthropometry and body composition, anthropometric indicators of nutritional status, circumferences, physical fitness and motor coordination variables of the low birth weight (LBW) and normal birth weight (NBW) groups.

	NBW (n = 198)		LBW (n = 155)		
Variables	**Mean**	**SD**	**Mean**	**SD**	***P***
Birth weight (g)	3299.5	226.5	2363.9	160.6	0.000
Age (decimal)	8.31	1.08	8.5	1.1	0.051
Anthropometry and Body Compositions					
Weight (Kg) §	26.4	4.4	25.5	4.7	0.036
Height (cm) §	128.3	6.8	125.1	7.8	0.034
BMI (Kg/m^2)	15.9	1.4	15.5	1.1	0.007
Sitting Height (cm) §	65.8	4.1	65.5	4.5	0.501
Spam Acromion (cm) §	23.7	3.1	23.8	3.1	0.801
Body Fatness (%)§	14.9	4.5	15.2	5.1	0.616
Fat Mass (kg) §	4.0	1.8	4.0	2.2	0.808
Fat Free Mass (kg) §	22.5	3.3	21.7	3.2	0.021
Anthropometric indicators of nutritional status					
Weight/age (kg/year)	3.2	0.5	3.0	0.5	0.002
Height/age (cm/year)	15.5	1.6	15.1	1.5	0.003
Weight/height (kg/cm)	0.2	0.0	0.2	0.0	0.282
Skinfold Thickness					
Triceps (mm) §	8.7	2.8	8.8	3.3	0.993
Biceps (mm) §	5.3	1.8	5.5	3.2	0.792
Subscapular (mm) §	5.7	1.8	5.9	2.6	0.724
Suprailiac (mm) §	5.5	2.6	5.8	3.9	0.582
Abdominal (mm) §	7.0	3.2	7.1	3.9	0.992
Geminal (mm) §	9.1	3.7	9.0	4.2	0.542
Circumferences					
Arms (cm)	17.9	1.5	17.1	1.3	0.030

Waist (cm)	55.9	4.2	55.2	4.4	0.073
Geminal (cm)	25.2	2.2	24.7	2.2	0.011
Physical Fitness					
Sit and Reach (cm) §	31.7	4.1	32.0	4.3	0.478
Right Handgrip Strength (kg/f) §	10.9	3.1	10.1	3.0	0.010
Left Handgrip Strength (kg/f) §	11.3	10.5	9.9	2.9	0.026
Curl-ups (number of repetitions/mim) §	10.2	5.2	9.8	4.5	0.783
Standing Long Jump (cm) §	125.0	16.3	124.6	17.9	0.684
Running speed in 20m distance (s) §	4.19	0.3	4.15	0.2	0.257
Motor Coordination					
Balancing backwards §	44.0	8.9	46.1	10.2	0.049
One-legged obstacle jumping §	42.8	8.5	42.8	8.3	0.901
Jumping from side to side §	55.9	12.1	55.1	12.2	0.515
Sideway movements §	38.2	5.3	36.8	4.9	0.007
Motor Quotient (MQ)	121.9	11.1	120.1	13.2	0.912

§= log-transformed data for the *t* - test. NBW = normal birth weight; LBW = low birth weight; BMI = body mass index.

Table 2 - Means (±standard errors) of low birth weight (LBW) and normal birth weight (NBW). Anthropometry and body composition, anthropometric indicators of nutritional status, circumferences, physical fitness and motor coordination indicators, significant covariates and p-values.

	NBW (n = 198)		LBW (n = 155)				
Variables	**Mean**	**SEM**	**Mean**	**SEM**	***Covariates***	**F**	***P-value***
Anthropometry and Body Compositions							
Weight (Kg)	26.3	0.14	25.7	0.16	Gender, age, height, FST	7.604	0.006
Height (cm)	128.7	0.31	126.3	0.35	Gender, age, spam	25.146	0.000

					acromion		
BMI (Kg/m^2)	15.8	0.07	15.5	0.81	Gender, age, spam acromion, FST	4.290	0.039
Fat Free Mass (kg)	22.2	0.11	22.08	0.13	Gender, Age, height, sitting height, FST	0.532	0.466
Anthropometric indicators of nutritional status							
Weight/age (kg/year)	3.16	0.02	3.06	0.02	Body size, gender, FST	7.889	0.005
Height/age (cm/year)	15.5	0.1	15.04	0.1	Body size, gender, FST	12.052	0.001
Circumferences							
Arms (cm)	17.7	0.58	17.7	0.06	Body size, age, gender, FST	0.214	0.644
Legs (cm)	25.0	0.08	24.9	0.09	Body size, age, gender, FST	0.611	0.162
Physical Fitness							
Right Handgrip Strength (kg/f)	10.7	0.15	10.3	0.05	Age, body size, gender, FST	3.556	0.038
Left Handgrip Strength (kg/f)	11.1	0.5	10.1	0.1	Age, body size, gender, FST	4.554	0.011
Motor Coordination							
Balancing backwards	44.2	0.63	45.8	0.71	Age, body size, gender, FST	2.892	0.090
Sideway movements [§]	38.2	0.33	36.7	0.36	Age, body size, gender, FST	8.758	0.003

NBW = normal birth weight; LBW = low birth weight; BMI = body mass index; FST = fatness skinfold thickness (triceps, biceps, subscapular, suprailiac, abdominal and germinal); Body size (weight, height, fat free mass, fat mass, sitting height and spam acromion).

7. CONSIDERAÇÕES FINAIS

7. Considerações Finais

Está pesquisa teve como objetivo Avaliar a influência do baixo peso ao nascer sobre a antropometria, composição corporal, aptidão física e coordenação motora, nas crianças moçambicanas de idade entre 7 – 10 anos residentes na cidade de Maputo

De acordo com os objetivos do artigo original e o da revisão, destacamos as seguintes conclusões:

Artigo de Revisão	*Low birth weight, very low birth weight and extremely low birth weight in African children aged between 0 – 5 y old: a systematic review* 1) As crianças MBPN e EBPN apresentaram uma desvantagem com relação a mortalidade, atraso no crescimento, distúrbios neurológicos 2) Não está claro se estes déficits são permanentes ao longo das diferentes fases do crescimento ou podem ser atenuados ou revertidos.
Artigo original	*Birth weight and anthropometry, body composition, physical fitness, motor coordination of children aged 7 – 10 years from Maputo city, Mozambique* 1) Nas crianças de Maputo BPN parece ser o principal fator que influencia antropometria mas não aptidão física e componentes neuromotores. 2) Para a aptidão e coordenação motora, BPN é um forte preditor apenas para performance da força muscular e transfêrencia de plataforma.

Perspectivas

Os resultados deste estudo monstram como BPN exerce uma influência no crescimento e desenvolvimento da criança. Nestes resultados faltam nos a informação sobre os fatores ambientais mediando às relações entre o peso ao nascer e as condições na qual o sujeito está envolvido. Resta nos sabermos se estes déficits perduram para a vida adulta, sugerindo se estudos longitudinais. Os estudos longitudinais consistirão em acompanhamento das crianças que nasceram baixo peso, desde o nascimento, infância, adolescência, juventude e vida adulta. Iremos analisar as condições socioeconômicas, atividade física, alimentação, educação, o meio social em volta dessas crianças, em suma iremos acompanhar toda a trajetória delas.

Iremos também fazer intervenções, isto é, aplicaremos baterias de testes, para vermos até que ponto a prática de exercício físico pode reverter este cenário de baixo peso ao nascer. Estes testes serão realizados num meio bastante controlado pelos profissionais de Educação Física. Não iremos só intervir a nível desportivo, mas também nos padrões alimentares. O nosso país é rico em frutas, vegetais, legumes, vários tipos de peixes e mariscos, vários tipos de carnes, no entanto iremos propor a introdução da merenda escolar em todas as escolas primárias e secundárias do país.

A Educação Física é uma disciplina que visa criar o hábito da prática de exercício físico, não só na escola, mas para o resto da vida, de modo a combater o aparecimento precoce de doenças cardiovasculares e diabetes tipo 2 e promover o crescimento saudável na criança e proporcionar nas crianças uma qualidade da vida melhor. Mas infelizmente a Educação Física tem falhado nesse seu objetivo, muito em parte porque essa disciplina aparece tarde na vida da criança, começa na adolescência já no segundo grau do ensino primário. Até essa altura a criança já desenvolveu hábitos que muitas vezes o adolescente difilmente se desapega deles, por exemplo, vídeo games, televisão, redes sociais etc. com tudo isso iremos propor a quem de direito, para que a Educação Física inicie seriamente no primeiro ano escolar da criança.

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APÊNDICE

Apêndice

PHYSICAL FITNESS AND BIRTH WEIGHT IN YOUNG MEN FROM MAPUTO CITY, MOZAMBIQUE

APTIDÃO FÍSICA E PESO AO NASCER EM JOVENS DA CIDADE DE MAPUTO, MOÇAMBIQUE

APTITUD FÍSICA Y PESO AL NACER EN HOMBRES JÓVENES DE LA CIUDAD DE MAPUTO, MOZAMBIQUE

ORIGINAL ARTICLE
ARTIGO ORIGINAL
ARTÍCULO ORIGINAL

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ABSTRACT

Introduction: Birth weight has been considered an important marker of the nutritional transition in developing countries. Objective: To evaluate the influence of birth weight on body composition and physical fitness of young men born in Maputo, Mozambique. Methods: One hundred and seventy-nine students (aged 19 to 22 years) were divided into four groups (low birth weight < 2.500 g, LBW, n = 49; insufficient birth weight ≥ 2.500 g and < 3.000 g, IBW, n = 27; normal birth weight ≥ 3.000 g and < 3.999 g, NBW, n = 74; and high birth weight > 3.999 g, HBW, n = 31). Anthropometry and body composition were measured. Physical fitness was assessed by handgrip strength, muscle endurance, flexibility, agility, and running speed. Results: IBW showed lower values of body mass and fat free mass while LBW and HBW had high values of hip circumference, suprailiac, subscapular and abdominal skinfold when compared to NBW. LBW and HBW showed a high percentage of individuals with low performance in flexibility, right handgrip, agility, abdominal resistance, arms strength, and horizontal long jump. Around 70% of HBW showed low performance in the running speed test. Conclusion: Both low and high birth weight can influence adult adiposity and the performance in physical fitness tests.

Keywords: muscular strength, physical fitness, birth weight, young adult.

RESUMO

Introdução: O peso ao nascer tem sido considerado um marcador importante da transição nutricional nos países em desenvolvimento. Objetivo: Avaliar a influência do peso ao nascimento na composição corporal e aptidão física de homens jovens nascidos em Maputo, Moçambique. Métodos: Cento e setenta e nove estudantes (com idades entre 19 a 22 anos) foram divididos em quatro grupos (baixo peso ao nascer < 2.500 g, BPN, n = 49; peso insuficiente ao nascer ≥ 2.500 g e < 3.000 g, PIN, n = 27; peso normal ao nascer ≥ 3.000 g e < 3.999 g, PNN, n = 74; e peso elevado ao nascer > 3.999 g, PEN, n = 31). Foram avaliadas a antropometria e a composição corporal. A aptidão física foi avaliada por testes de força de preensão manual, resistência muscular, flexibilidade, agilidade e velocidade de corrida. Resultados: PIN mostrou menores valores de massa corporal e massa livre de gordura, enquanto BPN e PEN apresentaram altos valores de circunferência do quadril, supra-ilíaca, subescapular e dobra cutânea abdominal quando comparados com PNN. BPN e PEN mostraram um alto percentual de indivíduos com baixo desempenho em termos de flexibilidade, preensão palmar direita, agilidade, resistência abdominal, força de braço, e salto em distância horizontal. Cerca de 70% dos PEN apresentaram baixo desempenho no teste de velocidade de corrida. Conclusão: Ambos baixo e alto peso ao nascer podem influenciar a adiposidade no adulto e o desempenho em testes de aptidão física.

Descritores: *força muscular, aptidão física, peso ao nascer, adulto jovem.*

RESUMEN

Introducción: El peso al nacer ha sido considerado un importante marcador de la transición nutricional en los países en desarrollo. Objetivo: Evaluar la influencia del peso al nacer en la composición corporal y la aptitud física de los jóvenes nacidos en Maputo, Mozambique. Métodos: Ciento setenta y nueve estudiantes (de 19 a 22 años) se dividieron en cuatro grupos (bajo peso al nacer < 2.500 g, BPN, n = 49; peso insuficiente al nacer ≥ 2.500 g y < 3.000 g, PIN, n = 27; peso normal al nacer ≥ 3.000 g y < 3.999 g, PNN, n = 74; y peso elevado al nacer > 3.999 g, PEN, n = 31). Se evaluó la antropometría y composición corporal. La aptitud física se evaluó mediante la fuerza de prensión, resistencia muscular, flexibilidad, agilidad y velocidad de carrera. Resultados: PIN mostró valores más bajos de masa corporal y masa libre de grasa, mientras que el BPN y PEN tenían valores altos de circunferencia de la cadera, suprailiaco, subescapular y pliegue abdominal en comparación con PNN. BPN y HBW mostraron un alto porcentaje de personas con bajo rendimiento en flexibilidad, fuerza de prensión de la mano derecha, agilidad, resistencia abdominal, fuerza de los brazos, y salto de longitud horizontal. Alrededor del 70% de HBW mostró bajo rendimiento en la prueba de velocidad de carrera. Conclusión: Tanto bajo y alto peso al nacer pueden influir en la obesidad de adultos y el desempeño en las pruebas de aptitud física.

Descriptores: *fuerza muscular, aptitud física, peso al nacer, adulto joven.*

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INTRODUCTION

During the period of 1980 to 1992, a civil war began in Mozambique placing it among the poorest countries in the world with serious socioeconomic problems[1]. This situation that harried Mozambique was also characterized by food restrictions and a lack of consumables[2]. After the peace agreement of 1992, there was an improvement in the urbanization, sedentary occupations, availability of private transport and to the advent of "fast food", particularly in the capital, Maputo[1]. Mozambican children who were born and growing under that war environment presented changes in the pattern of height and weight per age as seen in previous studies[2]. Prista et al.[2] compared the growth status of a sample of school children, measured just after the end of civil war (in 1992), with a sample of school children 7 years after war (1,098 boys and 1,173 girls, age 6–17 years). Height, weight, BMI, fat mass, and lean body mass were always higher in the sample (7 years later civil war) than in the children evaluated in 1992, showing the recovery of growth status after the war.

According to previous study, Mozambique has passed for a nutritional transition since the prevalence of stunting has decreased dramatically in Maputo schoolchildren while the prevalence of overweight has increased[2]. Over the period of 1992 to 2000, the proportion of subjects with stunted growth dropped from 34.5% to 3% in males and from 24.6% to 2.3% in females, whereas the proportion of overweight subjects increased from 0% to 4.8% in males and from 4.9% to 7.7% in females[3]. This scenario of nutritional transition has been shared among low and middle-income countries that are accompanied by demographic and epidemiological transition associated with economic development and urbanization[4]. Birth weight has been considered an important marker of the nutritional transition because; both infant obesity and adult short stature were associated with fetal growth and the range of birth weight[5]. High levels of physical inactivity and sedentary lifestyle have also been associated with the nutrition transition in several countries[6].

Focusing on life-course plasticity, a large number of epidemiological studies have shown that the birth weight and the low level of nutritional intake early life followed by alterations in growth trajectory and metabolism, may impact on subsequent obesity risk[5,7]. There is an inverse association between low birth weight (<2,500 g) and risk of the metabolic syndrome[8]. Likewise, excessive birth weight (>4,000 g) was associated with increased risk of obesity (OR, 2.07; 95%, CI =1.91 to 2.24)[9]. In terms of motor performance, birth weight was considered an important determinant of the variance of neuromotor development in children[10] and an inducer of permanent deficits in muscle strength and running speed performance[11].

However, little is known about the effects of low birth weight on physical fitness in young men. Our hypothesis is that birth weight is a lifespan predictor of body fat, fat-free-mass and physical fitness in the direction of high fat mass accumulation and low level of physical fitness. Thus, our main goal was to evaluate the influence of birth weight on the anthropometry, body composition and physical fitness of young men. Ours findings suggest that extreme of birth weight (low and high) can influence body composition and the performance of some physical fitness tests.

MATERIAL AND METHODS

This study was conducted in the Maputo city, capital of Mozambique, a traditionally low-income region in Africa. A total of 179 male students (aged 19 to 22 years), born in Maputo-Mozambique, were divided into four groups according to their birth weight (low birth weight < 2.500 g, LB, n=49, insufficient birth weight ≥2.500 g and<3.000 g, IBW: n=27, normal birth weight ≥3.000 g and<3.999 g, NBW, n=74; and high birth weight > 3.999g, HBW, n=31).Birth weight was obtained from the health booklets in which this information was recorded by nurses and/or pediatricians. Written Informed Consent was obtained from the participants and the study was approved by the Ethical Committee of the local health authority (National Committee of Bioethics for Health, protocol number Ref.74/CNBS).

Height and sitting height erect was measured to the nearest 1.0 cm using a portable stadiometer (Holtain, Crymych, United Kingdom) with the participant's head positioned in the Frankfurt horizontal plane[12]. Bodyweight was measured to the nearest 0.1 kg with a digital scale (M 01-22-07-245; Secca, Germany). Body mass index (BMI) was calculated using the standard formula [weight (kg)/height^2 (m)]. Triceps and subscapular skinfolds were measured with a Langer caliper (Lange, Santa Cruz, California, USA). Body fat percentage, fat mass (Kg) and fat free mass (Kg) were calculated using the formulas described in previous studies[13]. All measurements were done according to the procedures outlined in previous study[13]. The arm and leg circumference was obtained with a flexible tape measure with precision of 0.1 cm, according to the conventional techniques. Hip circumference was measured at the widest point between the buttocks and the iliac crest. Waist circumference was measured at the midpoint between the lower ribs and the iliac crest in accordance with standard procedures[14].

Physical fitness was assessed according to FITNESSGRAM and EUROFIT standardized test batteries, including: (1) handgrip strength (measured in each hand independently using a hand-grip dynamometer (Saehan, Flintvile, USA); (2) standing long jump (expressing the explosive power of lower limbs); (3) "curl-ups" (as an indicator of dynamic muscle endurance); (4) "sit and reach" as a measure of flexibility; (4) square test (time to travel a distance in a square with 4x4 meters with changes in direction) as a measure of agility; (5) 20-meter run measuring speed.

The performance of each test was analyzed and it was divided in tercis of performance, thus, three categories were formed: <25% low performance, 50% median, and >75% high performance. It was taken these values to analyze the performance of the groups and results were expressed in percentage into the categories as well as the absolute number of subjects.

Statistical analysis

Statistical analysis was conducted with SPSS (SPSS Inc., Chicago, IL), version 17.0 and Graphpad Prism 5.0 programs. Exploratory data analysis was used to identify possible inaccurate information and the presence of outliers and to test the assumption of normality in all data distributions. Kolmogorov-Smirnov and Shapiro-Wilk normality tests were applied in total sample. For data with normal distribution was used analysis of variance (ANOVA). Post hoc examinations were conducted with Bonferroni post-hoc test. Nonparametric data were analyzed by using Mann-Whitney *U* test. Statistical significance was set at $P < 0.05$ for all analysis.

RESULTS

Descriptive analyses of anthropometry and body composition of the total sample are shown in Table 1.

When sample were divided according to the birth weight, anthropometry and body composition were not different among groups (Table 2). Exception was seen for IBW group that showed lower values of body mass and fat free mass than NBW.

LBW and HBW showed high values of hip circumference when compared to NBW (Figure 1A). The hip/waist ratio was not different among groups (NBW = 0.78 ± 0.3; LBW = 0.77 ± 0.2; IBW = 0.76 ± 0.3;

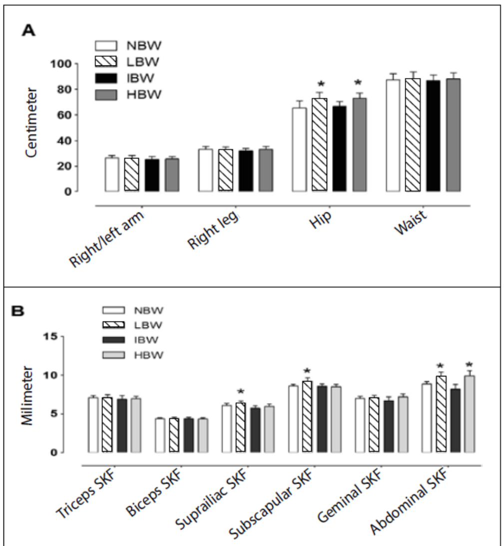
Table 1. Total sample descriptive characteristics (Means ± SEM, minimum and maximum) of physical growth, body composition and physical fitness variables.

	Mean ± sd (n=179)	Min	Max
Birth Weight (g)	3170 ± 0.052	1000	5000
Age (years)	18.8 ± 0.09	17.0	22.0
Growth and Body Composition			
Weight (Kg)	61.1 ± 0.58	42.0	84.0
Height (cm)	171.0 ± 0.50	151.0	194.0
BMI (Kg·m^{-2})	20.8 ± 0.15	16.2	28.4
Body Fatness (%)	22.5 ± 0.26	15.0	35.8
Fat Mass (kg)	13.9 ± 0.26	6.3	29.6
Fat Free Mass (kg)	47.2 ± 0.40	32.9	62.3
Waist/Hip	0.78 ± 0.002	0.70	0.91

Table 2. Descriptive analyses of anthropometry and body composition of young men aged 19 – 22 y old divided according to their birth weight. Normal birth weight (NBW), low birth weight (LBW), insufficient birth weight (IBW) and highbirth weight (HBW).

	Groups				
	NBW	LBW	IBW	HBW	
	(n=72)	(n=48)	(n=27)	(n=31)	*p*
Birth weight (kg)	3.35 ± 0.23	2.36 ± 0.27	2.83 ± 0.10	4.28 ± 0.32	0.000
Age (years)	18.9 ± 1.2	18.9 ± 1.2	18.3 ± 0.9	18.8 ± 1.4	0.098
Anthropometry					
Body mass (Kg)	62.3 ± 7.2	60.6 ± 8.9	57.4 ± 6.8[a]	62.2 ± 7.5	0.044
Body height (cm)	172.2 ± 7.3	169.2 ± 6.7	170.1 ± 5.9	171.1 ± 5.2	0.060
Body Mass Index (Kg/m^2)	20.9 ± 1.9	20.9 ± 2.0	20.0 ± 1.8	21.0 ± 2.1	0.111
Seating height erect (cm)	85.6 ± 3.8	85.1 ± 4.0	83.7 ± 3.5	85.8 ± 3.7	0.120
Body Composition					
∑ skinfold triceps and subscapular (mm)	15.6 ± 3.6	16.3 ± 5.1	15.4 ± 3.7	15.4 ± 3.1	0.747
Fat mass (%)	15.5 ± 1.1	15.8 ± 2.3	14.8 ± 1.4	15.5 ± 1.7	0.220
Fat mass (Kg)	9.8 ± 1.9	9.8 ± 2.9	8.6 ± 1.7	9.8 ± 2.1	0.145
Fat free mass (Kg)	52.6 ± 5.4	50.8 ± 6.3	48.8 ± 5.2[a]	52.4 ± 5.5	0.025

[a]P<0.05 vs NBW by one-way ANOVA and post-hoc Tukey test.



* *P*<0.05 vs NBW by one-way ANOVA and post-hoc Tukey test.

Figure 1. Descriptive analyses of the right/left arm, right leg, hip, and waist circumferences (A) and triceps, biceps, suprailiac, subscapular, germinal and abdominal subcutaneous skinfolds (B) of young men aged 19–22 y old born with normal birth weight (NBW, n=72), low birth weight (LBW, n=48), insufficient birth weight (IBW, n=27) and high birth weight (HBW, n=31). Values are expressed as means and standard deviations.

Table 3. Descriptive analyses of physical fitness of young men aged 19–22 years old born with normal weight (NBW), low weight (LBW), insufficient weight (IBW) and high weight (HBW). Values are expressed in median (minimal and maximal values).

	NBW (n = 72)	LBW (n = 48)	IBW (n = 27)	HBW (n = 31)
	Median (Min – Max)	Median (Min – Max)	Median (Min – Max)	Median (Min – Max)
Sit and Reach (cm) [Flexibility]	36.6 (20 – 50)	33.7 (14 – 45)	36.1 (10 – 49)	33.4 (15 – 53)
Time to perform a distance in a square with 4x4 meters (s) [Agility]	7.6 (5.4 – 10.3)	7.9 (6.0 – 11.4)	7.7 (6.6 – 9.6)	7.9 (5.4 – 9.1)
Running speed in 20 meter test (s) [Speed]	5.2 (3.9 – 7.0)	5.3 (3.4 – 7.7)	5.2 (4.1 – 6.9)	5.6 (3.9 – 7.0)
Right handgrip (Kgf)	46.3 (31 – 59)	44.9 (32 – 71)	42.4 (26 – 54)	44.3 (27 – 62)
Left handgrip (Kgf)	44.3 (30 – 61)	42.3 (28 – 65)	42.2 (30 – 58)	42.2 (28 – 55)
Curl-Ups (n° of repetitions/min)	34 (16 – 66)	32.2 (20 – 76)	36 (17 – 72)	34.4 (16 – 76)
Standing Long jump (cm)	184.9 (123 – 260)	182.4 (129 – 226)	184.2 (126 – 229)	172.6[a] (137 – 230)

[a]P<0.05 vs NBW by using Kruskall-Wallis test and post-hoc Dunn test.

HBW = 0.78 ± 0.2, p> 0.05). Peripheral subcutaneous skinfolds (biceps, triceps and germinal) did not alter among groups (Figure 1B). On the other hand, LBW groups showed high values of central subcutaneous skinfold (suprailiac, subscapular and abdominal) when compared to NBW. HBW group showed higher abdominal skinfold than NBW group (Figure1B).

Physical fitness did not differ when groups were compared, except for HBW group that showed low values for horizontal long jump when compared to NBW (Table 3).

LBW and HBW showed a higher percentage of individuals with a low performance of flexibility, right and left handgrip strength, and horizontal long jump. It is interesting to note that HBW individuals showed a high percentage of low performance in all physical fitness tests except for arm strength. LBW and HBW groups showed a higher percentage of low performance in abdominal resistance, arms strength, and horizontal long jump. Around 30 - 40% of young men from LBW, IBW and HBW showed a low performance in the curl-up test (Figure 2A-B).

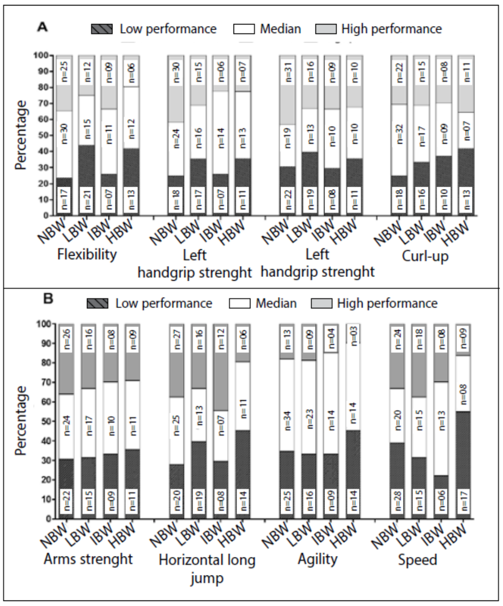


Figure 2. Frequency analyses of the performance in each test of physical fitness. Young men born with normal weight (NBW, n=72) were divided in tercis of performance in each physical fitness test (>25% low performance, 50% median, and <75% high performance). Low birth weight (LBW, n=48), insufficient birth weight (IBW, n=27) and high birth weight (HBW, n=31).Values are expressed in percentage into each categories of tercis from NBW.

DISCUSSION

Experimental and clinical studies have linked the birth weight and early disturbs during child development with the risk of degenerative diseases such as stroke, hypertension, obesity and type 2 diabetes in adult life[15,16]. In human, these observations were replicated in both from industrialized countries [7] and also those undergoing the nutritional transition[17,18]. In African countries, previous studies have shown the effects of birth weight on growth and development during childhood[19]. For example, in Keneba, the Gambia, birth weight have been inversely associated with impaired adult bone strength, male and female 7 to 21 years[20]. Fetal size was also inversely related to systolic blood pressure in childhood in Zimbabwe and in South Africa[21]. Due to its historical background, it is important to consider the influence of birth weight (low, insufficient and excessive) on the body composition and physical fitness of young men from Maputo, Mozambique. For our knowledge, this is the first study that considered motor performance susceptible to early events in life in a sample from Mozambique.

We found that our sample presented a normal BMI (> 20 and < 25) and normal mean values of anthropometric and body composition according to the National Centre for Health Statistics standards. However, in the present study, insufficient birth weight influenced significantly for a lower adult weight and fat free mass. This influence is aligned with previous studies[22]. Similarly, the differences in the hip and abdominal skinfold thicknesses, as well as in the indices of central fat distribution (waist-hip and skinfold ratios) seen in the LBW and HBW are in accordance with earlier findings[17,23]. It seems that both low and excessive birth weight can predict more strongly adult adiposity than adult lean mass. One of the best-known attempts to understand this central riddle of the association between birth weight and late risk of fat accumulation is the "phenotype thrifty hypothesis" proposed by Hales and Barker[24]. This hypothesis proposed that perinatal stimuli/insults (for example, malnutrition, smoke, antigens, drugs and alcohol) induces physiological and metabolic adaptations in a short-term, but with later consequences on the risk of obesity, diabetes type 2, hypertension and metabolic diseases[25]. However, the thrifty phenotype hypothesis emphasized the role developmental experience in shaping subsequent metabolism, in-dependent of genotype. The mechanism described above may involve either genetic adaptation, or mechanisms of plasticity, and at this stage neither can be ruled out[25].

Recently, it was proposed a new theoretical model for cardiovascular disease risk highlighting birth weight as an index of 'metabolic capacity' (organ structure and function that emerge during fetal life and infancy promoting the maintenance of homeostasis), and several factors in childhood (large tissue masses, sedentary behavior and high-fat diet) as indices of 'metabolic load' that challenge the ability to maintain homeostasis[26]. According to this model, body size and adiposity are predicted to increase metabolic load, whereas low birth weight is predicted to reduce metabolic capacity[26]. Metabolic load may be further exacerbated by sedentary behavior, which is associated with impaired motor performance during childhood with repercussions for young men.

In the present study, birth weight did not influence mean values of physical fitness performance in young men except for standing long jump in the HBW group. In contrast with our findings, previous studies have shown that LBW subjects aged 10–20 y have lower performance in tests for physical fitness assessment when compared to normal birth weight control subjects[27,28]. However, when it was not considered the mean values but the individual performance, the extreme of birth weight (LBW and HBH) showed a high percentage of individual with low performance. Thus, when groups were also analyzed in terms of performance categories, and it was found that high birth weight strongly influenced the performance in all physical fitness tests except for arm strength. More than 50% of individuals born with high weight showed a low performance in the horizontal long jump. This result can be related to the phenotype changes in skeletal muscle development as seen in both animals and human beings. In previous study, 20 healthy 19-yr-old men with low birth weight presented +66% of type IIx at expense of decreased type IIa fibers (-22%)[29]. In animals, LBW pups showed a reduced oxidative fibers (type I) and increased glycolytic fiber (type IIb) in adult animals[30]. Additional studies with more detailed parameters of metabolic and structural analysis would help to understand the mechanisms by which adverse environmental stimuli, here represented by birth weight, may affect physical performance later in life.

Physical fitness is often related to components such as cardiovascular fitness, muscular strength and endurance, body composition and flexibility. Studies involving physical fitness have analyzed its relationship with the risks for chronic diseases[31,32]. For instance, higher cardiorespiratory fitness has been associated to lower predisposition to cardiovascular and metabolic diseases[31], overweight, hypercholesterolaemia, and hypertension[32]. Muscular strength and endurance are related to lower risks for heart disease, enhance of lean mass, reduced incidence of low back pain, osteoarthritis, osteoporosis and risk of injuries[31]. In addition, flexibility has been related to benefits such as reduced injury risk, prevention or reduction of post-exercise soreness[33]. Both LBW and HBW could result directly in reduced physical fitness including reduced muscle strength due to low muscle mass, and an insufficient aerobic capacity related to low cardiorespiratory fitness in young adult[6].

CONCLUSION

Low and middle-income countries have experienced a rapid economic and urbanization development, and nutritional transition that can be considered the major compelling force behind the risk of obesity-related diseases. In the present study, we found that both low and high birth weight can predict more strongly adult adiposity. The high percentage of subjects with low performance in flexibility, right handgrip, and agility tests was seen in LBW and HBW subjects. Thus, the extreme of birth weight (low and high) can influence body composition and the performance of some physical fitness tests.

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CONTRIBUIÇÕES DOS AUTORES: All authors contributed individually and significantly for this multi-institutional study. MET(0000-0003-3808-1240)*, AP and CGL participated actively in the conduction of the study, data analysis and revision of the manuscript. MBA(0000-0001-7286-7736)* and MAM (0000-0002-2734-8416)* participated in the data analysis and revision of manuscript. MET and CGL (0000-0001-6176-1688)* conducted the process of revision and final version of the study. *ORCID Number (*Open Researcher and Contributor ID*).

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ANEXOS

Anexos

ANEXO A. Comprovante do envio do artigo de revisão no Journal of Developmental Origins of Health and Disease (DOHaD).

ANEXO B. Comprovante do envio do artigo original na revista Developmental Medicine and Child Neurology.

ANEXO C. Parecer de comité de ética em pesquisa

ANEXO D. Comunicado aos pais ou responsáveis sobre os procedimentos, avaliações e testes.

ANEXO E. Ficha de avaliação antropométrica, composição corporal e aptidão física.

ANEXO F. Ficha de avaliação do desempenho motor - KTK

Anexo A

Assunto:	Journal of Developmental Origins of Health and Disease - Account Created in Manuscript Central
De:	doheditorial@cambridge.org (doheditorial@cambridge.org)
Para:	mariotchamo@yahoo.com.br;
Data:	Terça-feira, 2 de Fevereiro de 2016 17:14

02-Feb-2016

Dear Dr. Tchamo:

A manuscript titled Low birth weight, very low birth weight and extremely low birth weight in African children aged between 0 – 5 y old: a systematic review (DOHaD-02-16-RE-0625) has been submitted by Dr. Mario Tchamo to the Journal of Developmental Origins of Health and Disease.

You are listed as a co-author for this manuscript. The online peer-review system, Manuscript Central, automatically creates a user account for you. Your USER ID and PASSWORD for your account is as follows:

Site URL: https://mc.manuscriptcentral.com/dohad
USER ID: mariotchamo@yahoo.com.br
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https://mc.manuscriptcentral.com/dohad?URL_MASK=bdc3e3e63bea4ee2810ed981347454fb

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Thank you for your participation.

Sincerely,
Journal of Developmental Origins of Health and Disease Editorial Office

Anexo B

Enc: Developmental Medicine & Child Neurology - Account Created in ScholarOne Manuscripts

Mário Tchamo <mariotchamo@yahoo.com.br> 3 de fevereiro de 2016 às 09:35
Para: Mário Tchamo <mariotchamo@gmail.com>

Em 13:12 Ter, 2 de fev de PM, dmcn@editorialoffice.co.uk <dmcn@editorialoffice.co.uk> escreveu:

> 02-Feb-2016
>
> Dear Dr Tchamo
>
> A manuscript titled Persistent deficits in anthropometric indices of nutritional status and motor performance in low birth weight children from Maputo city, Mozambique (DMCN-OA-16-02-0067) has been submitted by Dr Mario Tchamo to Developmental Medicine & Child Neurology.
>
> You are listed as a co-author for this manuscript. The online peer-review system, ScholarOne Manuscripts, automatically creates a user account for you. Your USER ID and PASSWORD for your account is as follows:
>
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> USER ID: mariotchamo@yahoo.com.br
> PASSWORD: https://mc.manuscriptcentral.com/dmcn?URL_MASK=88f7d7362dba4a5c8bf83134d9f7d269
>
> You can use the above USER ID and PASSWORD to log in to the site and check the status of papers you have authored/co-authored. This password is case-sensitive. Please log in to https://mc.manuscriptcentral.com/dmcn to update your account information and change your password.
>
> Thank you very much for your help.
>
> Yours sincerely,
> Developmental Medicine & Child Neurology Editorial Office

Anexo C

REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DA SAÚDE

COMITÉ NACIONAL DE BIOÉTICA PARA A SAÚDE
IRB00002657

Exmo Senhor
Dr. Mário Eugénio Tchamo
UP

Ref: 181/CNBS/2014 **Data 20 de Junho de 2014**

Assunto: Parecer do Comité Nacional de Bioética para saúde (CNBS) sobre o estudo: "*Influência do peso ao nascer sobre o estado nutricional, os níveis de actividade física habitual, aptidão física e desenvolvimento neuro-motor de crianças moçambicanas residentes na Cidade de Maputo na idade de 7 a 10 anos*"

No dia 20 de Junho de 2014, o Comité Nacional de Bioética para Saúde (CNBS) fez a revisão das correcções efectuadas no protocolo ***"Influência do peso ao nascer sobre o estado nutricional, os níveis de actividade física habitual, aptidão física e desenvolvimento neuro-motor de crianças moçambicanas residentes na Cidade de Maputo na idade de 7 a 10 anos"***;
Registado no CNBS com o número 48/CNBS/2014, conforme os requisitos da Declaração de Helsínquia,
Não havendo nenhum inconveniente de ordem ética que impeça a realização do estudo, o CNBS dá a sua devida aprovação aos seguintes documentos:

- Protocolo (versão III) de 2014
- Consentimento informado (versão III) de 2014
- Instrumentos de Recolha de dados (versão III) de 2014

Todavia, o CNBS informa que:

1- A lista actualizada dos membros do CNBS esta disponível na secretaria do Comité.
2- Não houve declaração de conflitos de interesse por nenhum dos membros do CNBS .
3- A aprovação terá a validade de um ano, terminando esta a 20 de Junho de 2015. Os investigadores deverão submeter o pedido de renovação da aprovação um mês antes de terminar o prazo.
4- Recomenda-se aos investigadores que mantenham o CNBS informado do decurso do estudo.
5- A presente aprovação não substitui a autorização administrativa.

Com as nossas mais cordiais saudações.

O Presidente

Dr. João Fernando Lima Schwalbach

ENDEREÇO:
MINISTÉRIO DA SAÚDE
C. POSTAL 264
Av. Eduardo Mondlane/Salvador Allende
MAPUTO – MOÇAMBIQUE

Telefones: 430814/427131(4)
Telex: 6-239 MISAU MO
FAX: 258 (1) 426547
258 (1) 33320

Anexo D

EFEITO DO PESO AOS NASCER SOBRE A COMPOSIÇÃO CORPORAL, INDICADORES ANTROPOMÉTRICOS DE ESTADO NUTRICIONAL, APTIDÃO FÍSICA E COORDENAÇÃO MOTORA DE CRIANÇAS MOÇAMBICANAS NA IDADE ENTRE 7 – 10 ANOS RESIDENTES NA CIDADE DE MAPUTO

CONSENTIMENTO INFORMADO DO ENCARREGADO DE EDUCAÇÃO

O que deve saber sobre a pesquisa

• Damos-lhe este formulário de consentimento para quepossa ler sobre os objectivos, riscos e benefícios deste estudo.

• Tem o direito de se recusar a participar, ou pode mesmo concordar e mudar de ideia mais tarde.

• Por favor, leia este formulário de consentimento com atenção e faça todas as perguntas que julgar necessárias antes de tomar uma decisão.

• A sua participação e de seu educando é voluntária.

• Ao assinar este formulário de consentimento,concorda e permite que o seu educando participe do estudo

1 - Quem está a realizar o estudo?

Investigador Principal: Mestre Mário Tchamo, da Universidade Pedagógica. Neste momento o referido investigador se encontra a frequentar o doutoramento na Universidade Federal de Pernambuco, Brasil.

2 - Onde este o estudo está sendo conduzido?

A coleta de dados será realizada na escola do seu educando.O tempo de duração previsto para a avaliação de seu educando neste estudo será de 1 hora ou menos na escola. Os testes consistem numa observação de equilíbrio e coordenação, numa bateria de medidas antropométricas, aptidão física e actividade física.

3 - Qual é o objectivo deste estudo?

O objectivo deste estudo é determinar a influência do peso ao nascer sobre o estado nutricional, nível de atividade física habitual, aptidão física e desenvolvimento neuro-motor de crianças moçambicanas na idade de 7 a 10 anos residentes na cidade de Maputo.

4 - Quem é elegível para participar do estudo? Quem é inelegível?

Seu educando é elegível para o estudo, se:

• O encarregado de educação concorda (ao assinar este formulário)em participar no estudo.

• A criança entregou nos o cartão de peso onde consta o seu peso ao nascer.

Seu educando não vai ser elegível para o estudo no caso de:

• O encarregado de educaçãoou o seu educando não assinar o termo de consentimento indicando que aceitam ser voluntários para o estudo.

• Seu educando tiver algum tipo de deficiência que o impeça de fazer alguns tipos de actividade.

5. 0 que o seu educando vai fazer?

O seu educando vai realizar uma bateria de testes que consistem na observação de equilíbrio e coordenação, numa bateria de medidas antropométricas, aptidão física.

6 - Quais são os possíveis riscos e desconfortos ?

Este é um estudo de risco mínimo. Não há aspectos do estudo, que estejam previstos para aumentar o risco de ferimentos para o seu educando. Todos os testes são realizados nos padrões de segurança internacionalmente aprovados.

7 - Quais são os possíveis benefícios?

Não há nenhum benefício directo para o seu educando. No entanto, os resultados da pesquisa podem auxiliar nadefenição de futuras intervenções no domínio da actividade física que potencialmente ajudarão as crianças a se tornarem mais saudáveis .

8 - Se tiver dúvidas ou problemas, a quem você pode chamar?

Se tem alguma dúvida sobre seus direitos como voluntário de pesquisa, pode telefonar para o mestre Mário Tchamo pelo celular848154909 ou para o Comité Nacional de Bioética em Saúde pelo numero 21430814/21427131(4)

9 - Quais são as informações serão mantidas em sigilo?

Todos os dados serão colectados de forma confidencial. Todos os esforços serão feitos para manter a confidencialidade dos registos de estudos e de seu educando. A cada participante vai ser atribuído um número de identificação único na ficha de Coleta de dados. Uma lista separada será depositada de forma segura na sede internacional do projecto a qual só será utilizada para identificar os participantes para fins de re-contato. Os resultados do estudo poderão ser publicados mas todas as informaçõesde identificação pessoal serão mantidas sigilosas. Excepto-se qualquer caso em que a divulgação seja exigida por lei.

10– O seu educando pode ou não abandonar a sua participação?

O seu educando pode ser retirado do estudo por qualquer motivo ou mesmo sem motivo. O encarregado de educação e seu educando podem retirar-se do estudo a qualquer momento, semqualquer penalização.

11- Assinatura

Este estudo foi me apresentado e todas as minhas questões foram respondidas. Se houver algo que eu não entenda eu posso perguntar aos investigadores ou a qualquer membro da equipa.

O voluntário é um criança que eu certifico ser meu legal educando

Escola:____

Nome da criança ____

Nome do Encarregado de

Educação____

Sexo:_____________Data de Nascimento____/____/_______/Idade_________

Nome de Encarregado de Educação____

Relação com a criança(pai, tio, irmão, etc)_______________________________________

Investigador em Moçambique:

Mestre Mário Tchamo

Estudante de doutoramento na Universidade Federal de Pernambuco - Brasil

Faculdade de Educação Física e Desporto – UP

Centro de Investigação e Desenvolvimento do Desporto e Actividade Física

E-mail: mariotchamo@yahoo.com.br

Cel: 848154909

Anexo E

Nome ____

Escola ______________________ Ano _____Turma _____Sexo ______

Data Nascimento ___/___/__ Data avaliação___/___/___

FICHA DE AVALIAÇÃO ANTROPOMÉTRICA

Peso.. [ ] [ ] Peso ao nascer: [ ] [ ]

Altura.. [ ] [ ]

Altura sentado............................. [ ] [ ] **(-50cm banco)**

Tricipital SKF..............................	1ª	2ª	M
Bíceps SKF..................................	1ª	2ª	M
Suprailiaca..................................	1ª	2ª	M
Subescapular SKF.......................	1ª	2ª	M
Perímetro Cefálico........................	1ª	2ª	M
Panturrilha media SKF.................	1ª	2ª	M

Perímetro do Braço Relaxado.........	1ª	2ª	M
Perímetro Geminal.........................	1ª.	2ª.	M
Perímetro da Cintura	1ª.	2ª.	M

]

FICHA DE AVALIAÇÃO DA APTIDÃO FÍSICA RELACIONADA À SAÚDE

1. Flexibilidade-Sentar e alcançar: [ ]
2. Pressão manual Direita [ ] Esquerda [ ]
3. *Abdominais* 1min T1 [ ] T2 [ ]
4. Impulsão horizontal s/corrida prep. T1 [ ] T2 [ ] RF [ ]
5. Corrida de vai e vem 20M [ ]

Anexo F

FICHA DE COLETA DE DADOS DO TESTE K.T.K

Identificação
Nome: Sexo:
Data nascimento: / / Data da Avaliação: / /2014

1. Tarefa Equilíbrio na trave

Trave	1	2	3	Soma
6,0 cm				
4,5 cm				
3,0 cm				
		Total		
		MQ1		

2. Tarefa Salto Monopedal

Altura	0	5	10	15	20	25	30	35	40	45	50	55	60	Soma
Direita														
Esquerda														
						Total								
						MQ2								

3. Tarefa Salto lateral

Saltar 15 segundos	1	2	Soma
	Total		
	MQ3		

4. Tarefa Transferência de plataforma

Saltar 20 segundos	1	2	Soma
	Total		
	MQ4		

Soma de QM1 até QM4 __________
Total de QM _______
Classificação: ______

Avaliador(a)____

Data_______/_______/_______