Artigo Original

Vitamin E deficiency and associated factors among Brazilian school children

Deficiência de vitamina E e fatores associados entre crianças escolares brasileiras

Viviane Imaculada do Carmo Custódio[1], Carlos Alberto Nogueira-de-Almeida[2], Luiz Antonio Del Ciampo[3], Fábio da Veiga Ued[4], Ane Cristina Fayão Almeida[5], Rodrigo José Custódio[6], Alceu Afonso Jordão Júnior[7], Júlio César Daneluzzi[8], Ivan Savioli Ferraz[9]

ABSTRACT

Objective: Brazilian national data show a significant deficiency in pediatric vitamin E consumption, but there are very few studies evaluating laboratory-proven nutritional deficiency. The present study aimed to settle the prevalence of vitamin E deficiency (VED) and factors associated among school-aged children attended at a primary health unit in Ribeirão Preto (SP). **Methods**: A cross-sectional study that included 94 children between 6 and 11 years old. All subjects were submitted to vitamin E status analysis. To investigate the presence of factors associated with VED, socioeconomic and anthropometric evaluation, determination of serum hemoglobin and zinc levels, and parasitological stool exam were performed. The associations were performed using Fisher's exact test. **Results**: VED (α-tocopherol concentrations <7 μmol/L) was observed in seven subjects (7.4%). None of them had zinc deficiency. Of the total of children, three (3.2%) were malnourished, 12 (12.7%) were anemic, and 11 (13.5%) presented some pathogenic intestinal parasite. These possible risk factors, in addition to maternal-work, maternal educational level, and monthly income, were not associated with VED. **Conclusions**: The prevalence of VED among school-aged children attended at a primary health unit was low. Zinc deficiency, malnutrition, anemia, pathogenic intestinal parasite, maternal-work, maternal educational level, and monthly income were not a risk factor for VED.

Keywords: Child; Vitamin E Deficiency; Risk Factors.

RESUMO

Objetivo: Determinar a prevalência da deficiência de vitamina E (DVE) e os fatores associados a essa deficiência em escolares atendidos em uma unidade básica de saúde de Ribeirão Preto (SP). **Métodos:** Estudo transversal que incluiu 94 crianças entre 6 e 11 anos de idade, atendidas em uma unidade básica de saúde. Todos os indivíduos foram submetidos à análise do *status* de vitamina E. Para investigar a presença de fatores associados à DVE, foi realizada avaliação socioeconômica e antropométrica, determinação dos níveis séricos de hemoglobina e zinco, e exame parasitológico de fezes. As associações foram realizadas por meio do teste exato de Fisher. **Resultados:** A DVE (concentrações de α-tocoferol <7 μmol/l) foi observada em sete indivíduos (7,4%). Nenhum sujeito apresentou deficiência sérica de zinco. Do total de crianças, três (3,2%) eram desnutridas, 12 (12,7%) anêmicas e 11 (13,5%) apresentavam algum parasita intestinal patogênico. Estes possíveis fatores de risco, além do trabalho materno, escolaridade materna e renda mensal, não foram associados à DVE (p>0,05). **Conclusão:** A prevalência de DVE em escolares atendidos em uma unidade básica de saúde foi baixa. Desnutrição, anemia, parasitose intestinal, renda mensal e trabalho e nível educacional maternos não se apresentaram como fatores de risco para a DVE.

Palavras-chave: Criança; Deficiência de Vitamina E; Fatores de Risco.

1 Médica. Professora Titular do Departamento de Pediatria do Centro Universitário Barão de Mauá, Ribeirão Preto (SP), Brasil.
2 Médico. Professor Assistente do Departamento de Medicina da UFSCAR, São Carlos (SP), Brasil.
3 Médico. Professor Doutor do Departamento de Puericultura e Pediatria da Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo (FMRP-USP), Ribeirão Preto (SP), Brasil.
4 Nutricionista. Doutorando em Saúde da Criança e do Adolescente no Departamento de Puericultura e Pediatria da FMRP-USP, Ribeirão Preto (SP), Brasil.
5 Nutricionista da Unidade de Emergência do HCFMRP-USP, Ribeirão Preto (SP), Brasil.
6 Médico. Professor Titular do Departamento de Pediatria do Centro Universitário Barão de Mauá, Ribeirão Preto (SP), Brasil.
7 Biólogo, Professor Associado do Departamento de Ciências da Saúde da FMRP-USP, Ribeirão Preto (SP), Brasil.
8 Médico. Professor Aposentado do Departamento de Ciências da Saúde da FMRP-USP, Ribeirão Preto (SP), Brasil.
9 Médico. Professor Doutor do Departamento de Puericultura e Pediatria da FMRP-USP, Ribeirão Preto (SP), Brasil.

✉ Carlos Alberto Nogueira-de-Almeida. Rua Eugênio Ferrante, 170, Jd. Nova Aliança Sul. CEP: 14027-150. Ribeirão Preto (SP), Brasil.
dr.nogueira@me.com | Recebido em: 19/05/2020 | Aprovado em: 18/08/2020

https://doi.org/10.11606/issn.2176-7262.v53i4p424-429

INTRODUCTION

Vitamin E (VE) is an essential lipid-soluble antioxidant nutrient required in small quantities for important biological processes. The VE role in oxidative stress has been widely studied, in addition to its participation in immunomodulation and several metabolic processes[1]. VE (tocopherol) is a generic term for several compounds. Among them, α-tocopherol is the major VE form and represents over 90% of all plasmatic tocopherols.

In adult men, not only higher serum α-tocopherol concentrations were related to lower general mortality, but also cancer and cardiovascular diseases were lower[1,2]. VE suboptimal serum levels are accepted as a risk factor for degenerative diseases; furthermore, the coronary artery disease severity was related to decreased VE[2]. In childhood, the role of VE was clearly shown in premature infants that had received VE deficient formula; those children developed hemolytic anemia and edema[3]. Moreover, VE, probably, is required for a normal neurological function[4].

The severe VE deficiency (VED) may cause various degrees of neurologic deficits, hemolytic anemia, impaired lipid absorption, and could lead to a progressive neurological syndrome including cerebellar ataxia and posterior cord injury; nevertheless, a severe deficiency is rare and may occur related to a specific anomaly of hepatic VE or intestinal secretion of VE, excessive endogenous consumption, abetalipoproteinemia, cystic fibrosis, chronic cholestatic liver disease, short-bowel syndrome, and other fat malabsorption syndromes[4-6].

Like other nutritional deficiencies, in addition to the VE low ingestion, such as protein-calorie undernourishment and low consumption of fruits and vegetables[7], other factors like low serum zinc levels, iron deficiency anemia, parasitic infestation, and low socioeconomic profile may be associated with VED and can aggravate and/or contribute to this deficiency[8].

Studies regarding healthy schoolchildren VE status in developing countries are lacking, but some authors showed insufficient ingestion[9]; thus, this study aimed to evaluate the VE inappropriate concentrations prevalence in schoolchildren enrolled in a primary health care service in Ribeirão Preto (SP, Brazil) and verify the association between some risk factors and this condition.

METHODS

Study design and sampling

This is a cross-sectional descriptive study addressed also by analytic designs. All 104 children aged 6 to 11 years old attending a public primary pediatric clinic at Ribeirão Preto (São Paulo, Brazil) between September 2013 and March 2014, who after the routine pediatric appointment were not receiving VE supplements, were invited to take part in the study. Of these, ten were excluded because they had a fever, diarrhea, or hemorrhagic disease within 15 days prior to the appointment.

The purpose of the study was explained to the parents or legal guardians who also signed the written informed consent to the procedure. The study protocol was approved by the Research Ethics Committee of the University Hospital, Ribeirão Preto Medical School, University of São Paulo.

Demographic and socioeconomic data (maternal-work, maternal educational level, and monthly income) were obtained using a questionnaire-based interview with parents or legal guardians. The height and weight of children were also measured on the same day of blood sampling according to the procedure detailed[10-12], and the body mass index (BMI) was calculated.

After at least 6 hours of fasting, blood samples were obtained to measure α-tocopherol, hemoglobin, and zinc concentrations. Plasma α-tocopherol concentrations were measured by HPLC[13]; hemoglobin levels were determined by the Coulter STKS method (Coulter Corporation, Hialeah, FL, USA); and serum zinc was obtained by flame atomic absorption spectrophotometry (SpectrAA 55B, Varian, Techtron, Victoria, Australia). Plasma α-tocopherol concentrations lower than 7 μmol/L were the cutoff for pediatric populations, and children with concentrations lower than that were considered as VED in this study[13]. Anemia was defined as hemoglobin concentration lower than 11.5 g/dL[14].

The normal plasma zinc range is 50-150 µg/dL. In this study, children with plasma zinc concentrations lower than 50 µg/dL were zinc deficient[15].

In order to evaluate intestinal parasitic diseases of the children, three stool samples were obtained by the parents on nonconsecutive days during the month of the study. Direct exam and spontaneous sedimentation method were used to determine the protozoan, nematodes presence[16], and zinc sulfate flotation[17].

In this study, the possible factors associated with VED that were investigated were: sex, maternal-work, maternal educational level (<8 years of maternal education), monthly income, BMI classification (z-scores less than -2 for the weight for age), anemia, zinc levels (< 50 µg/dL), and intestinal parasitosis.

Statistical analysis

Data were expressed as the number and percentage of subjects. Statistical analysis was performed by non-parametric methods. Fisher's test was used to determine whether there were nonrandom associations between VED and one of the following variables: sex, maternal-work, maternal educational level, BMI classification, anemia, and parasitic infestation. Whenever the data distribution was not normal (age, zinc serum values, monthly income), the Mann-Whitney test was used to compare the medians of the children with and without VED, with a 95% confidence level.

Malnutrition was defined as a weight-for-age, height-for-age, and weight/height z-scores < -2. The Epi Info program version 2002 software (Centers for Disease Control and Prevention) was used to calculate the height for age, weight for height, and weight for age z-scores, comparing them with the National Center for Health Statistics standard reference population[18].

The research project was approved by the Research Ethics Committee on 08/04/2003, according to the HCRP process no. 6007/2003.

RESULTS

A total of 94 children participated in the study, of which 48 (51.0%) were male. Plasma α-tocopherol concentrations <12 µmol/L were observed in 31 (33.0%) children. These values were <7 µmol/L in seven (7.4%) subjects. Among the children with VED, 28.6% (2 out of 7) were boys, and 71.4% (5 out of 7) were girls. According to the gender, there was no significant difference (2 out of 48 boys; and 5 out of 46 girls) regarding the prevalence of VED (p=0.26) (Table 1).

Table 1
Data of the children with and without VED

Variable	VED[(a)] present	VED[(a)] absent
Boys	28.6%	52.9%
Girls	71.4%	47.1%
Hb[(b)] < 11.5g/100ml	0.0%	14.0%
Hb[(b)] ≥ 11.5g/100ml	100.0%	86.0%
Maternal-work	71.4%	56.3%
Unemployed or housekeeper	28.6%	43.8%
≤ 8 years of maternal education	85.7%	67.8%
>8 years of maternal education	14.3%	32.2%
NMSPC[(c)] median	0.94	0.71

[(a)] VED: vitamin E deficiency; [(b)] Hb: hemoglobin; [(c)] NMSPC: national minimum salary per capita.

The age medians of children with and without VED were 7.08 and 7.92 years old, respectively. No significant difference was observed when they were compared (p=0.35). Among all children analyzed, two patients had z-scores less than -2 for the weight for age and one patient had weight for height z-score less than -2. None of them were with VED.

Serum zinc was measured in 87 children, and no child showed serum zinc levels <50 µg/dL. Two children without VED had the lowest zinc concentration (60 µg/dl). The groups with and without VED had similar zinc concentrations medians: 93 µg/dL and 92 µg/dL, respectively (p=0.50). Furthermore, 12.7% (12 out of 94) children were anemic, and

there was no association between anemia and VED in this group (p=0.59) (Table 1).

Fecal samples were obtained from 81 subjects (median of three samples), and 11 (13.5%) children had some pathogenic intestinal parasite. *Giardia lamblia* and *Enterobius vermicularis* were the most frequently found pathogens (8.6 and 7.4%, respectively). The simultaneous presence of *G. lamblia* and *E. vermicularis* was found in two children. There was no relation between helminths and protozoan intestinal infections and VED in this group (p=0.53).

All children studied were registered at public schools. Maternal work, maternal educational level, and monthly income (analyzed by the national minimum salary per capita - NMSPC) were not associated with VED (p=0.69, 0.43, 0.35, respectively) (Table 1).

DISCUSSION

Studies regarding the VE status in healthy schoolchildren in developing countries are scarce, although some authors believe that it is a prevalent deficiency, with important consequences, like anemia[19]. Part of this situation could be attributed to the fact that the VE normal range criterion for serum levels among children has been a cause of concern[20]. Numerous studies have assumed serum levels lower than 12 µmol/L as a criterion for inadequate α-tocopherol concentrations in pediatric populations[21,22]. Notwithstanding, in other studies, VED in children has been defined as plasmatic concentrations of either total tocopherol or α-tocopherol lower than 7 µmol/L.

Drewel et al. (2006) verified that 68% of US healthy children aged 2-5 years had total tocopherol concentrations lower than 7 µmol/L[23]. Although using a different criterion, other studies have reported 66 and 69% of preschool healthy children with serum α-tocopherol lower than 12 µmol/L[21,24]. Augusto et al., evaluating 702 Brazilian children aged 4 to 10 years, with low consumption of fruits and vegetables, showed that 9% had VED[7].

Our data pointed few VED children. VE is found in vegetable oils, whole grains, sunflower seeds, wheat germ, and dark green leafy vegetables[25]. Regarding dietary VE, most people consume less than the estimated average requirement (EAR) of VE even in developed countries; this fact can lead to an inadequate VE status that is usually clinically asymptomatic[2], but, taking into account the anti-oxidant effects of VE, it is probably an important anti-inflammatory vitamin that could have relevant effect in the management of inflammatory diseases[26]. Children fed with milk fortified with vitamin E have low LDL-Cholesterol, showing that vitamin status is important for an adequate cholesterol status in childhood[27]. In the school-aged children, the current VE EAR is 6 mg of α-tocopherol per day[25].

The low prevalence of VED we found may be due to the fact that these children have access to good sources of VE like soy oil and bean, both largely consumed by Brazilian people[28-30]. Moreover, all children enrolled in this study were registered at public schools where balanced meals are prepared under the control of nutritionists and offered to the students daily. However, these hypotheses require further specific investigations.

Even though the majority of the 6- to 11-year-old children included in this study were considered without VED, it is important to analyze possible risk factors that may be correlated with this condition to contribute to the improvement of the suspicion of marginal VED in children.

Schoolchildren, in general, have lower rates of morbidity, mortality, and nutritional deficiencies compared to infants and preschoolers, a fact that may explain the relatively few studies on this age range[8]. In our study, the age of children did not influence the prevalence of VED.

Hoeft, Weber, and Eggersdorfer pointed out that vitamin deficiencies are the most common in male children[8]. Nevertheless, in this study, there was no difference between boys and girls regarding VED.

Although few malnourished children were observed, malnutrition was not related to VED. Subclinical VED in apparently well-nourished children represents part of one of the most important nutritional problems, hidden hunger. This phenomenon had been reported before[31, 32].

The deficiency of multiple micronutrients is common. VE serum levels may be decreased in association with zinc deficiency[33]. Nevertheless, the lowest zinc values observed in our children were

not related to VED. There was also no association between VED and iron deficiency anemia.

The overall prevalence of intestinal parasite infections among children in this study was low (13.5%). Similar data were found by Muniz et al.[34] This can be mostly attributed to the urbanization process with the improvement of sanitation in Southwest Brazil, but is the note the case in poor regions of the country where hygienic problems persist [35]. Similar to other variables studied, in the present study, the intestinal-parasitic infections were not related to VED either.

In this study, we could not detect socioeconomic-demographic factors influences the VE status. Hoeft, Weber, and Eggersdorfer, in a different way, verified that malnutrition and micronutrient deficiencies are still highly prevalent and related to lower-income families and less educated mothers[8].

The main limitation of the present study was the lack of food intake assessment using standardized and validated instruments. This would help to understand the prevalence of 7.4% of DVE. Another limitation of this study is the relatively small number of subjects, which may have restricted the power of the analyses performed. For this reason, the children of the present study cannot be considered representative of Brazilian schoolchildren. On the other hand, there is a lack of information about VED among healthy schoolchildren, and these data may contribute to this issue.

In conclusion, our data showed that 7.4% of school-aged children presented subclinical VED. Gender, anemia, serum zinc, malnutrition, intestinal parasitosis, and some socioeconomic-demographic factors were not correlated with VED. Despite this fact, VED should be better identified and evaluated to support appropriate actions in order to improve health status in this age group and, consequently, the elimination of VED repercussions on the future of these children.

REFERENCES

1. Traber MG, Frei B, Beckman JS. Vitamin E revisited: do new data validate benefits for chronic disease prevention? Current Opinion in Internal Medicine. 2008;7:155-163.10.1097/mol.0b013e3282f2dab6
2. Schwenke DC. Nutrition and metabolism: α-Tocopherol to prevent cardiovascular disease – deficiency, dose, delivery, and developing context. Current Opinion in Lipidology. 2008;19:203-207.10.1097/mol.0b013e3282f8afc0
3. Oski FA, Barness LA. Vitamin E deficiency: A previously unrecognized cause of hemolytic anemia in the premature infant. The Journal of Pediatrics. 1967;70:211-220.10.1016/s0022-3476(67)80416-5
4. Baumgartner MR. Vitamin-responsive disorders. Handbook of Clinical Neurology: Elsevier; 2013. p. 1799-1810.
5. Feki M, Souissi M, Mebazaa A, editors. Vitamin E deficiency. Etiopathogenesis, clinical, histopathologic, and electrical features, and main etiologies. Annales de medecine interne; 2001.
6. Sapiejka E, Krzyzanowska-Jankowska P, Wenska-Chyzy E, Szczepanik M, Walkowiak D, Cofta S, et al. Vitamin E status and its determinants in patients with cystic fibrosis. Adv Med Sci. 2018;63:341-346.10.1016/j.advms.2018.04.001
7. Augusto RA, Cobayashi F, Cardoso MA. Associations between low consumption of fruits and vegetables and nutritional deficiencies in Brazilian schoolchildren. Public Health Nutr. 2015;18:927-935.10.1017/s1368980014001244
8. Hoeft B, Weber P, Eggersdorfer M. Micronutrients - a Global Perspective on Intake, Health Benefits and Economics. International Journal for Vitamin and Nutrition Research. 2012;82:316-320.10.1024/0300-9831/a000125
9. de Castro MA, Verly E, Fisberg M, Fisberg RM. Children's nutrient intake variability is affected by age and body weight status according to results from a Brazilian multicenter study. Nutrition Research. 2014;34:74-84. https://doi.org/10.1016/j.nutres.2013.09.006
10. WHO Expert Committee on Drug Dependence: Twenty-eighth report. PsycEXTRA Dataset: American Psychological Association (APA); 1993.
11. Almeida CA, Ricco RG. Avaliação do estado nutricional com ênfase à antropometria. Pediatria (São Paulo). 1998;20:385-398,
12. Jelliffe DB, Organization WH. Evaluación del estado de nutrición de la comunidad (con especial referencia a las encuestas en las regiones en desarrollo. 1968,
13. Farrell PM, Levine SL, Murphy M, Adams AJ. Plasma tocopherol levels and tocopherol-lipid relationships in a normal population of children as compared to healthy adults. The American journal of clinical nutrition. 1978;31:1720-1726,
14. WHO. Iron deficiency anemia. assessment, prevention, and control. Geneva: World Health Organization; 2001.
15. Kapil U, Bhadoria A, Sareen N. Correlates of zinc deficiency among children in age group of six to sixty months belonging to the low-income group. Journal of Family and Community Medicine. 2013;20:139.10.4103/2230-8229.114778

16. Hoffman WA, Pons JA, Janer JL. The sedimentation-concentration method in schistosomiasis mansoni. 1934,

17. Faust EC, Tobie J, Thomen LF, Sawitz W, D'Antoni JS, Peres C, et al. A Critical Study of Clinical Laboratory Technics for the Diagnosis of Protozoan Cysts and Helminth Eggs in Feces 1. The American Journal of Tropical Medicine and Hygiene. 1938;s1-18:169-183.10.4269/ajtmh.1938.s1-18.169

18. WHO. WHO Expert Committee on Physical Status: the use and interpretation of anthropometry. Geneva: World Health Organization; 1995.

19. Jilani T, Iqbal MP. Vitamin E deficiency in South Asian population and the therapeutic use of alpha-tocopherol (Vitamin E) for correction of anemia. Pakistan Journal of Medical Sciences. 2018;34:1571,

20. Dror DK, Allen LH. Vitamin E deficiency in developing countries. Food and nutrition bulletin. 2011;32:124-143,

21. Kim Y-N, Lora KR, Giraud DW, Driskell JA. Nonsupplemented Children of Latino Immigrants Have Low Vitamin E Intakes and Plasma Concentrations and Normal Vitamin C, Selenium, and Carotenoid Intakes and Plasma Concentrations. Journal of the American Dietetic Association. 2006;106:385-391.10.1016/j.jada.2005.12.010

22. Looker AC, Underwood BA, Wiley J, Fulwood R, Sempos CT. Serum alpha-tocopherol levels of Mexican Americans, Cubans, and Puerto Ricans aged 4–74 y. The American Journal of Clinical Nutrition. 1989;50:491-496.10.1093/ajcn/50.3.491

23. Drewel B, Giraud D, Davy S, Driskell J. Less than adequate vitamin E status observed in a group of preschool boys and girls living in the United States☆. The Journal of Nutritional Biochemistry. 2006;17:132-138.10.1016/j.jnutbio.2005.06.003

24. Giraud, Kim, Cho, Driskell. Vitamin E Inadequacy Observed in a Group of 2- to 6-Year-Old Children Living in Kwangju, Republic of Korea. International Journal for Vitamin and Nutrition Research. 2008;78:148-155.10.1024/0300-9831.78.3.148

25. Food, Staff NB, Antioxidants PoD, Staff IoM. Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium and Carotenoids: A Report of the Panel on Dietary Antioxidants and Related Compounds, Subcommittees on Upper Reference Levels of Nutrients and of Interpretation and Use of Dietary Reference Intakes and the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine: National Academies Press; 2000.

26. Wallert M, Börmel L, Lorkowski S. Inflammatory Diseases and Vitamin E–What Do We Know and Where Do We Go? Molecular Nutrition & Food Research. 2000097

27. Saran Netto A, Salles MSV, Roma Júnior LC, Cozzolino SMF, Gonçalves MTM, Freitas Júnior JE, et al. Increasing Selenium and Vitamin E in Dairy Cow Milk Improves the Quality of the Milk as Food for Children. Nutrients. 2019;11.10.3390/nu11061218

28. Clarke MW, Burnett JR, Croft KD. Vitamin E in Human Health and Disease. Critical Reviews in Clinical Laboratory Sciences. 2008;45:417-450.10.1080/10408360802118625

29. Souza N, Dutra de Oliveira J. Estudo experimental sobre o valor nutritivo de misturas de arroz e feijão. Rev Bras Pesq Méd Biol. 1969;2:175-180,

30. Veiga EV, Vannucchi H, Marchini JS, Dutra de Oliveira JE. The nutritive value of a rice and soybean diet for adults. Nutrition Research. 1985;5:577-583.10.1016/s0271-5317(85)80238-4

31. Ferraz IS, Daneluzzi JC, Vannucchi H. Vitamin A deficiency in children aged 6 to 24 months in Sao Paulo State, Brazil. Nutrition Research. 2000;20:757-768.10.1016/s0271-5317(00)00177-9

32. Ferraz IS, Daneluzzi JC, Vannucchi H, Jordão AA, Ricco RG, Del Ciampo LA, et al. Detection of vitamin A deficiency in Brazilian preschool children using the serum 30-day dose–response test. European Journal of Clinical Nutrition. 2004;58:1372-1377.10.1038/sj.ejcn.1601978

33. Bunk MJ, Dnistrian AM, Schwartz MK, Rivlin RS. Dietary Zinc Deficiency Decreases Plasma Concentrations of Vitamin E. Experimental Biology and Medicine. 1989;190:379-384.10.3181/00379727-190-42876

34. Muniz PT, Ferreira MU, Ferreira CS, Conde WL, Monteiro CA. Intestinal parasitic infections in young children in São Paulo, Brazil: prevalences, temporal trends and associations with physical growth. Annals of Tropical Medicine & Parasitology. 2002;96:503-512.10.1179/000349802125001311

35. Harvey TV, Tang AM, da Paixao Sevá A, Albano dos Santos C, Santos Carvalho SM, Magalhães da Rocha CMB, et al. Enteric parasitic infections in children and dogs in resource-poor communities in northeastern Brazil: Identifying priority prevention and control areas. PLOS Neglected Tropical Diseases. 2020;14:e0008378.10.1371/journal.pntd.0008378