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Intestinal Parasitosis among Primary School Pupils in Coastal Areas of the Cape Coast Metropolis, Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Authors KD, RKDE and SVN were involved in designing the study. Authors ROK, LA, KD did laboratory analysis, specimen and data collection. Authors ROK, LA and DAS performed the statistical analysis and managed the literature search. Authors KD, SVN and SEB wrote the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: Intestinal parasitosis remains a major public health burden in developing countries such as Ghana. The burden of disease is heaviest among vulnerable populations and yet epidemiologic data from these populations are limited.
Objectives: The present study aimed at assessing the prevalence and risk factors of intestinal

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parasitosis among primary school pupils in coastal communities of the Cape Coast metropolis in the Central Region of Ghana.
Methods: A cross-sectional survey of primary schools in coastal areas of the Cape Coast metropolis in the Central Region of Ghana was undertaken. Stool samples were collected and examined using wet mount and formol-ether concentration techniques. Data on socio-demography, environmental and hygiene behaviour was obtained through the administration of a structured questionnaire.
Results: Out of the 230 samples examined, 44 (19.1%) were positive for a least one intestinal parasite. The most predominant parasite in this study was *Giardia lamblia* (6.5%). Hookworm was the most common (3.9%) intestinal helminth seen in this study. The prevalence of *Ascaris lumbricoides*, *Trichuris trichiura*, *Schistosoma mansoni* and *Strongyloides stercoralis* were 3.0%, 2.2%, 1.7% and 1.7% respectively. Pit latrine toilet facility emerged as a risk factor for infection in this study.
Conclusion: Intestinal parasitosis is high in basic schools in coastal communities in Cape Coast. The provision of better and hygienic toilet facilities may be a significant boost to control measures.

Keywords: Intestinal parasitosis; primary school pupils; prevalence; risk factors; cape coast.

1. INTRODUCTION

Intestinal parasitosis continues to be a major public health problem with high prevalence and widespread distribution in several developing countries [1,2]. It is estimated that about 3.5 billion people are infected with intestinal parasites [3] and majority of these cases are children [4,5].

Intestinal parasitic infections are the main cause of morbidity and occasional mortality among the infected population worldwide. Although there has been a general improvement of health status of people, intestinal parasitosis still affects many communities. A combination of several factors including climatic, environmental, behavioural, and socioeconomic have ensured that the transmission of these intestinal parasites is sustained in some communities, especially deprived rural areas and the urban slums [6,7]. The burden of disease is particularly high in school children who are more likely to handle infested soils through their play, eat with soiled hands, and have unhygienic toilet practices [8,9]. The heavy burden of infection in this population makes them more susceptible to conditions associated with intestinal parasitosis such as malnutrition, anaemia, seizures, chronic diarrhea, delay intellectual development and stunted growth [10-12]. In developing countries, soil transmitted helminthes mainly affect poor people living in rural areas [13]. The consequence of intestinal parasitosis in endemic communities and vulnerable populations are serious and therefore warrants continuous monitoring to ensure prompt identification and action by health authorities.

Ghana continues to record cases of intestinal parasitosis. Ghana Health Service (GHS) reports suggest that soil transmitted helminthes are endemic in 138 districts of the 10 regions in Ghana even though the actual prevalence of intestinal parasitosis is yet to be properly assessed [14]. Data on disease occurrence collected by the GHS come as aggregates of hospital records on specific diseases and is reported per district. This method of data collection and presentation often obscures the actual burden of disease in vulnerable populations since these populations are not always delimited by district boundaries. Thus, compared the district, regional or national averages, the prevalence of intestinal parasitosis in vulnerable populations such as school pupils or children and pregnant women may be disproportionately higher. The identification of such vulnerable populations often requires focal epidemiological studies that are specifically designed to assess the burden of disease in the population of interest. This study aimed at determining the prevalence of intestinal parasitosis among primary school pupils in some coastal communities of the Cape Coast metropolis. It also investigated the risk factors associated with intestinal parasitosis in the study population.

2. MATERIALS AND METHODS

2.1 Study Design and Area

This was a school-based cross sectional study involving 230 pupils from coastal areas of the Cape Coast Metropolis in the Central Region of Ghana. The metropolis has a population of 169,894 people [15]. It is situated geographically

within latitudes 5º.07' to 5º.20' north of the Equator and between longitudes 1º.11' to 1º.41' west of the Greenwich Meridian covering a total land area of approximately 122 sq. km. The climate is tropical with wet rainy and dry harmattan seasons. The main occupation of the inhabitants of the coastal communities in Cape Coast is fishing and fish mongering.

2.2 Study Population

Study participants were clinically healthy children recruited from five (5) basic schools in the Metropolis namely Ekon M/A primary A (EA), Ekon M/A primary B (EB), Archbishop Amissah Attah primary (AAA), Wilson-Sey primary (WS) and Philip Quaicoo Boy's primary (PQ) in Cape Coast. A list of all schools in the Cape Coast Metropolis was obtained from the Metropolitan Education office. Five schools along the coast were selected by random sampling and included in the study. School pupils enrolled in the study were also sampled randomly using the class registers.

2.3 Ethical Considerations

The study was approved by The Institutional Review Board of the University of Cape Coast and permission was sought from the Metropolitan directorate of the Ghana Education Service in Cape Coast. Only pupils whose parents gave consent for their participation in the study were recruited.

2.4 Questionnaire Administration

A pretested structured questionnaire was administered to study participants. The questionnaire had common risk factors associated with intestinal parasitosis such as demographic, environmental and hygienic and behavioral factors.

2.5 Sample Collection

Samples were collected in February and March, 2014. A total of 230 stool samples were obtained from study participants. Participants were educated on how to produce and handle specimens to avoid contamination before being provided with the sample containers. Stool specimens were collected in a clean, wide mouth, screw capped and dry plastic containers. All containers were labeled with a sample number and school's name. The sample collection took place early in the mornings. All samples were sent immediately to the laboratory of the School of Medical Sciences, University of Cape Coast for processing and examination.

2.6 Sample Processing

Stool samples were collected on alternate days from each participant. After gross examination of sample characteristics, they were processed and examined microscopically by direct wet faecal preparation and staining in Lugol's iodine. Each sample was also concentrated by the formol-ether sedimentation technique for microscopic examination as described in [16].

2.7 Statistical Analysis

Survey and parasitological examination data were analyzed using and SPSS software version 16.0. The Mann-Whitney U test and Kruskal–Wallis test on ranks were used for all comparisons. Odds ratios (OR) were estimated for association of risk factors with intestinal parasitosis using linear regression models. Differences and associations were deemed significant at $p<0.05$.

3. RESULTS

Table 1 shows the prevalence of various intestinal parasites in the five (5) schools. Out of 230 samples examined, 44 were positive for at least one intestinal parasite giving an overall prevalence of 19.1% in the study. EA recorded the highest prevalence of 24.4% (10/41) followed by WS with the prevalence of 21.4% (9/42). EB recorded the lowest prevalence of 14.3% (6/42).

Table 2 shows the distribution of intestinal parasites among all five schools. The most predominant intestinal parasite in this study was *Giardia lamblia* with a prevalence rate of (6.5%) which was recorded in all five schools. Hookworm was the most predominant helminth with the prevalence rate of (3.9%) followed by *Ascaris lumbricoides* (3.0%); both were recorded in four out of the five schools studied. *Schistosoma mansoni* infection was highest in EA 7.3%. The lowest prevalence recorded (1.7%) were that of of *Strongyloides stercoralis* and *Trichuris trichiura*.

Table 3 shows associations between the various risk factors and intestinal parasitic infections among the school pupils in the Cape Coast metropolis. Among all the potential risk factors

explored, the type of toilet facility used (pit latrine) was significantly associated with intestinal parasitosis OR = 4.18, CI (1.03 -17.02) (*P*=0.046).

No significant association were found between variables such as sex, age group and educational levels of pupils and intestinal parasitic infection though male pupils and those in age group 9 to 11 appear to have higher risk of infection (*P*>0.05).

Similarly, no significant associations were found regarding the hygiene behavior of pupils such as washing hands before eating, after visiting the toilet, eating unwashed fruits sucking fingers and biting nails. While pupils who walk on barefoot appeared to have higher risk of infection with intestinal parasites, it was not statistically significant (*P*>0.05).

4. DISCUSSION

This study identified six different intestinal parasites and found the overall prevalence among school pupils in the Cape Coast Metropolis to be 19.1%. This value is high compared to the estimated prevalence of intestinal helminthes of 6.82% in the Cape Coast metropolis as reported by the Ghana Health Service (unpublished data). The vast difference in the prevalence of intestinal parasitosis in these children and the general population is not surprising because children are more vulnerable to infections due to a number of factors. Firstly, children may have an under developed immune system due to their limited exposure to environmental pathogens. Children are also more susceptible to these infections because of their play environment. The third and perhaps the most important factor are their poor hygiene habits. Finding a higher prevalence of intestinal parasitosis in school pupils than the general population in the Cape Coast metropolis suggests district level prevalence can sometimes obscure important surveillance data in vulnerable population such as school pupils and pregnant women. This disparity could also result from under reporting by health authorities. Whiles this study surveyed basic schools; the Ghana Health Service (GHS) relies on hospital data and therefore may miss cases that do not get to the hospitals.

The range and prevalence of intestinal parasites seen in this study differs from studies conducted in other parts of the country, sub region and beyond [17-25]. It must be noted that the prevalence of intestinal parasites is often focal and can be high or low depending on a myriad of factors, including geographical location, climate, sanitation situation, behavioral and socioeconomic factors [26-29]. Our study focused on school pupils in the coastal areas of

Table 1. Prevalence of intestinal parasites among the five schools

Schools	Number examined	Number infected	Prevalence (%)
EA	41	10	24.4
EB	42	6	14.3
AAA	47	8	17
PQ	58	11	19
WS	42	9	21.4
Total	230	44	19.1

EA= Ekon M/A primary school A, EB= Ekon M/A primary school B, AAA= Archbishop Amissah Attah primary school, WS= Wilson-Sey primary school, PQ= Philip Quaicoo boys primary school

Table 2. Distribution of intestinal parasites among pupils in different schools

Parasite	School					Total
	EA [n=41]	EB [n=42]	OK [n=47]	PQ [n=58]	WS [n=42]	[n=230]
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Giardia lamblia	3 (7.3)	2 (4.8)	3 (6.4)	5 (8.6)	2 (4.8)	15 (6.5)
Ascaris lumbricoides	2 (4.9)	0 (0.0)	1 (2.1)	2 (3.4)	2 (4.8)	7 (3.0)
Hookworm	0 (0.0)	2 (4.8)	2 (4.3)	3 (5.2)	2 (4.8)	9 (3.9)
Schistosoma mansoni	3 (7.3)	0 (0.0)	0 (0.0)	1 (1.7)	1 (2.4)	5 (2.2)
Strongyloides stercoralis	0 (0.0)	2 (4.8)	0 (0.0)	0 (0.0)	2 (4.8)	4 (1.7)
Trichuris trichiura	2 (4.9)	0 (0.0)	2 (4.3)	0 (0.0)	0 (0.0)	4 (1.7)

EA= Ekon M/A primary school A, EB= Ekon M/A primary school B, AAA= *Archbishop Amissah Attah primary school, WS= Wilson-Sey primary school, PQ= Philip Quaicoo boys primary school*

Table 3. Risk factors and intestinal parasitic infections among school pupils

Risk factors	Intestinal parasites		*P*-value
	No. infected (%)	OR (95% CI)	
Sex			
Male	28 (12.2)	1	
Female	16 (7.0)	1.04 (0.52-2.05)	0.91
Age group			
6-8	5(2.2)	1	
9-11	22(9.6)	1.83 (0.62-5.38)	0.27
12-17	16(7.0)	0.87 (0.29-2.61)	0.80
15-17	1(0.4)	0.56 (0.06-5.42)	0.61
Educational level			
Class 1-3	19 (8.3)	1	
Class 4-6	25 (10.9)	0.99 (0.51-1.93)	0.98
Drinking water source			
Tap	39 (17.0)	1	
Sachet	5 (2.2)	0.66 (0.24 – 1.82)	0.64
Well	0 (0.0)	3.1	-
Type of toilet facility used			
Water closet	11(4.8)	1	
Pit latrine	5(2.2)	4.18 (1.03 -17.02)	0.046*
Nearby bush	5(2.2)	1.05 (0.32 – 3.40)	0.94
Beach	22 (9.6)	0.97 (0.43 -2.17)	0.34
Public toilet	1(0.4)	0.23 (0.03- 1.93)	0.18
Washing hand before eating			
Yes	41 (17.8)	1.7 (0.45-2.50)	0.88
No	3 (1.3)	1	
Washing hands after visiting toilet			
Yes			
No	38 (16.5)	0.68 (0.28-1.64)	0.39
	6 (2.6)	1	
Eating unwashed fruits			
Yes	17 (7.4)	1.06 (0.37-3.08)	0.91
No	27 (11.7)	1	
Sucking fingers			
Yes	18 (7.8)	1.12 (0.57-2.19)	0.74
No	26 (11.3)	1	
Biting nails			
Yes	26 (11.3)	1.03 (0.53-2.01)	0.93
No	18 (7.8)	1	
Walking on bare foot			
Yes	38 (16.5)	1.57 (0.62-4.00)	0.34
No	6 (2.6)	1	

** Statistically significant at P = .05; OR =odds ratio; CI =confidence interval*

Cape Coast, which usually has challenges with environmental sanitation. Data from this study and elsewhere suggests that it may be imperative to identify which intestinal parasites are most prevalent in a particular area to better help control it.

The present study found the predominant intestinal pathogenic protozoa to be *Giardia lamblia* with a prevalence rate of 6.5%. A similar study involving primary school children in urban and periurban areas of Kumasi, in Ghana also reported *Giardia lamblia* as the most predominant parasite but with a higher prevalence of 16.8% [30]. Our finding also conforms to studies in Pinar Del rio in Cuba in which *Giardia lamblia* was found to be the commonest protozoa with a prevalence of 38.5% [31]. Infection with *Giardia lamblia* especially in these children can lead to malnutrition as it can reduce food intake, produce steathorrhea, maldigestion and malabsorption of carbohydrates and vitamins [32,33]. The Ghana government has embarked on a school deworming program which appears to have reduced the intestinal worm burden among school. However, *Giardia lamblia* infection which appears to be one of the leading causes of intestinal parasitosis among school pupils in Ghana has not been addressed.

Hookworm was the most predominant intestinal helminth with a prevalence of 3.9%. This is consistent with findings of similar studies conducted in Kintampo in Ghana and Akwa Ibom State, Nigeria [34,35]. Although the prevalence of *Ascaris lumbricoides*, *Trichuris trichiura*, *Strongyloides stercoralis* and *Schistosoma mansoni* were relatively low, their detection in the study population indicates they are still being transmitted and the prevalence could surge under suitable conditions. The prevalence of the soil transmitted helminthes was generally low in this study and may also be attributed to the mass chemotherapy undertaken by the Ghana Health Service in 2012 for school pupils [36].

The varying prevalence of intestinal parasites often reflects certain local factors pertaining to particular areas and so effective control initiatives will have to consider the risk factors peculiar to those areas. Identifying the risk factors helps in a better understanding of transmission of these parasites. The study revealed that among all the risk factors examined, the use of the pit latrine facility was significantly associated with intestinal parasitic infection. This outcome is in line with a similar study conducted in Dharan Municipality in Nepal in which the use of the pit latrine had a significant association with intestinal helminthes infection [35].

While our study showed that pupils within the ages of 9-11 years were most infected (9.6%), studies in other areas varies in ages of highest infection. In Pakistan, 8-12 years showed the highest infection [25] whereas in Nigeria, 3-8 years group showed the highest infection [34]. The active playing habits of school pupils usually bring them into contact with the soil and water contaminated with these parasites making them vulnerable to infection [9].

A limitation of this study is that more stool samples should have been obtained from study participants for the prevalence of intestinal parasitosis in our study population. Consecutive sampling and improved stool examination techniques such as floatation, cellophane tape method and Modified Ziehl-Neelsen staining would also have increased the recovery of other parasites.

5. CONCLUSION

The present study revealed that infection with intestinal parasites is an important health problem among basic school pupils in the coastal communities of the Cape Coast metropolis. The provision of hygienic toilet facilities, education and regular deworming of children will help in controlling the transmission of these parasites in the various schools.

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CONSENT

All authors declare that written informed consent was obtained from the participants.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Board of the University of Cape Coast (UCCIRB).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Odu N. Impact of mass deworming of school children in rural communitiees in Rivers State, Nigeria:option for programme sustainability. Acta Parasitologica. 2011; (2):20-24.
2. Montressor A, Crompton DWT, Hall A, Bundy DAP, Savioli L. Guidlines for evaluation of soil transmitted helminthiasis and schistosomiasis at community level. World Health organisation, Geneva Switzerland; 1998. WHO/CTD/SIP/98.1.
3. Keiser J, Utzinger J. The drugs we have and the drugs we need against major helminth infections. Adv Parasitol. 2010; 73:197-230.
4. Brooker S, Kabatereine NB, Smith JL, Mupfasoni D, Mwanje MT, Ndayishimiye

O, Lwambo NJ, Mbotha D, Karanja P, Mwandawiro C, et al. An updated atlas of human helminth infections: the example of East Africa. Int J Health Geogr. 2009;8:42.
5. Mehraj V, Hatcher J, Akhtar S, Rafique G, Beg MA. Prevalence and factors associated with intestinal parasitic infection among children in an urban slum of Karachi. PLoS One. 2008;3:e3680.
6. Mordi RM, Ngwodo POA. A study of blood and Gastro-intestinal parasites in Edo state. African Journal of Biotechnology. 2007;6:2201-2207.
7. Alli JA, Kolade AF, Okonko IO. Prevalence of intestinal nematode infection among pregnant women attending antenatal clinic at the University College Hospital, Ibadan. Advances in Applied Science Research. 2011;2:1-13.
8. Nwosu ABC. The community ecology of soil transmitted helminth infection of humans in a hyperendemic area of Southern Nigeria. Annals Tropical Medicine and Parasitology. 1981;75:197-203.
9. Montressor A, Crompton DWT, Gyorkos TW, Savioli L. Helminthes control in school age children: A guide for managers of control programmes. World Health organisation, Geneva Switzerland; 2002.
10. Hotez PJ, Bradley PJ, Bethony JM, King CH, Pearce EJ, Jacobs J. Helminthes infections: The great neglected tropical diseases; 2008.
11. Savioli L, Stansfield S, Bundy DA, Mitchell A, Bhatia R, Engels D, et al. Schistosomiasis and soil-transmitted helminth infections: Forging control efforts. Trans R Soc Trop Med Hyg. 2002;96:577-579.
12. Craig P, Ito A. Intestinal cestodes. Curr Opin Infect Dis. 2007;20:524-532.
13. Crompton DW, Nesheim MC. Nutritional impact of intestinal helminthiasis during the human life cycle. Annu Rev Nutr. 2002; 22:35-59.
14. Ghana Health Service. Two years strategic plan for integrated neglected tropical disease control in Ghana, 2007-2008; 2007.
Available:http://wwwmohghanaorg/UploadFiles/Publications (Accessed 25 August 2014)
15. Ghana Statistical Service. Population and Housing census, final results 2010; 2012.
Available:http://www.statsghana.gov.gh/docfiles/2010phc/Census2010 Summary report of final results.pdf (Accessed 30 August 2014)
16. Cheesbrough M. District Laboratory Practice in Tropical Countries (Part 1). 2nd ed. New York: Cambridge University Press; 2005.
17. Annan A, Crompton DW, Walters DE, Arnold SE, An investigation of the prevalence of intestinal parasites in pre-school children in Ghana. Parasitology. 1986;92:209-217.
18. Humphries D, Mosites E, Otchere J, Twum WA, Woo L, Jones-Sanpei H, et al. Epidemiology of hookworm infection in Kintampo North Municipality, Ghana: patterns of malaria coinfection, anemia, and albendazole treatment failure. Am J Trop Med Hyg. 2011;84:792-800.
19. Tay SCK, Twum WA, Abruquah HH. Epidemiological survey of soil transmitted helminths in occupational risk groups and non-school going children in the Kintampo North district of Ghana. Journal of the Ghana Science Association. 2010;12.
20. Nkrumah B, Nguah SB. *Giardia lamblia*: a major parasitic cause of childhood diarrhoea in patients attending a district hospital in Ghana. Parasite and Vectors. 2011;4:163.
21. Verweij JJ, Oostvogel F, Brienen EA, Nang-Beifubah A, Ziem J, Polderman AM. Short communication: Prevalence of Entamoeba histolytica and Entamoeba dispar in northern Ghana. Trop Med Int Health. 2003;8:1153-1156.
22. Eleni K, Sissay M, Ameha K, Mulugeta D. Prevalence of intestinal parasitic infections and their associations with anthropometric measurement of school children in selected primary school Wukro Town, Eastern Tigray, Ethiopia. International Journal of Current Microbiology and Applied Sciences. 2014;3:11-29.
23. Alamir M, Awoke W, Feleke A. Intestinal parasitic infection and associated factors among school children in Dagi primary school, Amhara National Regional State, Ethiopia. Health. 2013;5:1697-1701.
24. Ayalew A, Debebe T, Worku A. Prevalence and risk factor of intestinal parasites among Delgi school children, Noth Gondar, Ethiopia. Journal of Parasitology and Vector Biology. 2011;3:75-81.
25. Masoumeh R, Farideh T, Mitra S, Heshmatolla T. Intestinal parasitic infection

among school children in Golestan Province, Iran. Pakistan Journal of Biological Sciences. 2012;15:1119-1125.

26. Ramana KV. Intestinal parasitic infection: An overview. annals Tropical Medicine Public Health. 2012;5:279-281.
27. Bethony J, Brooker S, Albonico M, Geiger SM, Loukas A, Diemert D, Hotez PJ. Soil-transmitted helminth infections: ascariasis, trichuriasis, and hookworm. Lancet. 2006: 367:1521-1532.
28. Ismail MM, Rajapakse A, Suraweerra MGW, Weerasuriya K, Amarasinghe DKC. Some socioeconomic and health related factors and soil transmitted nematode infection. In:Yokogawa M, et al. editors. Collected papers on the control of soil transmitted helminthiasis. APCO. 1987; 4:23-28.
29. Saksirisampant W, Nuchprayoon S, Wiwanitkit V, Yenthakan S, Ampavasiri A. Intestinal parasitic infestation among children in an orphanage in Pathum Thani Province. J Med Assoc Thai. 2003;86:263-270.
30. Walana W, Tay SCK, Tetteh P, Ziem JB. Prevalence of intestinal protozoan infestation among primary school children in urban and peri-urban communities in Kumasi, Ghana. Science J Public Health. 2014;2:52-57.
31. Escobedo AA, Canete R, Nunez FA. Prevalence, risk factors and clinical features associated with intestinal parasitic infections in children from San Juan y Martinez, Pinar del Rio, Cuba. West Indian Med J. 2008;57:377-382.
32. Ankarklev J, Jerlstrom-Hultqvist J, Ringqvist E, Troell K, Svard SG. Behind the smile: cell biology and disease mechanisms of Giardia species. Nat Rev Microbiol. 2010;8:413-422.
33. Springer SC, Key JD. Vitamin B12 deficiency and subclinical infection with Giardia lamblia in an adolescent with agammaglobulinemia of Bruton. J Adolesc Health. 1997;20:58-61.
34. Opara K, Udoidung NI, Opara DC, Okon OE, Edosomwan EU, Udoh AJ. The impact of intestinal parasitic infections on the nutritional status of rural and urban school-aged children in Nigeria. Int J MCH AIDS. 2012;1:73-82.
35. Narayan G, Ritu A, Hari PN. Intestinal parasitosis in school going children of Dharan municipality, Nepal. Tropical Gastroenterology. 2009;30:147-154.
36. Ghana Health Service: Central Region annual report; 2012.
Availabe:http://wwwghanahealthserviceorg/document/Annual Report 2012 CRpdf 2013:35 (Accessed 4th June 2014)

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