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Accounting for recent trends in the prevalence of diarrhoea in the Democratic Republic of Congo (DRC): results from consecutive cross-sectional surveys

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ABSTRACT

Objectives: To analyse trends in diarrhoea prevalence by maternal education, access to clean water and improved sanitation, household wealth index; to identify the sources of variation and assess contribution of changes in socioeconomic characteristics in the Democratic Republic of Congo (DRC).

Design: Consecutive cross-sectional surveys.

Setting: DRC.

Participants: The databases contain information on 9748 children from the 2001 Multiple Indicators Cluster Survey and 7987 children from the 2007 Demographic and Health Survey.

Interventions: N/A.

Primary and secondary outcome measures: Whether the child had diarrhoea 14 days preceding the survey.

Results: The overall prevalence of diarrhoea decreased by 26 percent (from 22.1% in 2001 to 16.4% in 2007). Findings from the three complementary statistical methods are consistent and confirm a significant decrease in diarrhoea regardless of socioeconomic characteristics. Changes in behaviour and/or in public health policy seem to be the likely main source of the change. There were no significant changes in diarrhoea prevalence associated with variation of the population structure. It is worth mentioning that the decrease in diarrhoea prevalence is in contrast to the generalised poor living conditions of the population. Therefore, it is difficult to ascertain whether the decline in diarrhoea prevalence was due to real improvement in public-health policy or to data quality issues.

Conclusions: The decline of diarrhoea prevalence in our study need to be further investigated by conducting district-based or provincial-based studies to validate findings from household surveys such as Demographic and Health Surveys and Multiple Indicators Cluster Survey taking into account the current context of the country: ongoing conflict, poor socioeconomic and poor health infrastructure. However, improvement in living conditions such as access to clean water and improved sanitation will contribute to accelerate the reduction of diarrhoea prevalence as well as reduction of child mortality.

ARTICLE SUMMARY

Article focus

- With about 1% of the global population, the Democratic Republic of Congo (DRC) has the third highest diarrheal morbidity among under-five children and the fifth highest under-five death rate worldwide. Recent national surveys reports show a decrease in childhood diarrhoea prevalence from 22% in 2001 to 16% in 2007.
- Intuitively, the decrease in prevalence of diarrhoea could be explained by: (1) public health improvement nationally or selectively among some specific households and/or (2) increase in the proportion of children living in households with access to water, sanitation and hygiene. We apply appropriate statistical techniques (decomposition analysis and fixed effect regression models) to describe trends in diarrhoea prevalence, identify the actual sources of changes and assess the contribution of selected factors in the observed changes.
- We use data from two consecutive nationally representative household surveys to investigate trends in diarrhoea in the DRC.

Key messages

- Our results provide evidence of a significant decrease in diarrhoea prevalence regardless of socioeconomic characteristics considered.
- The findings indicate that changes in behaviour and/or in public health policy seem to be the likely main source of the observed changes. There were no significant changes in diarrhoea prevalence associated with variation of the population structure.
- However, childhood diarrhoea remains a very important public health issue in the DRC despite the observed decline.
- Moreover, the observed diarrhoea prevalence is in contrast to the poor living conditions and high mortality observed in the same period.
- Therefore, further studies at the district or provincial level are needed to validate our findings. These studies should take into account the current context of the country: ongoing conflict, poor socioeconomic and lack of access to health infrastructures and poor health infrastructure.

ARTICLE SUMMARY

Strengths and limitations of this study

- This is the first study of its kind in the DRC that describe trends, identify sources of changes and assess factors contributing to the changes in diarrhoea prevalence among under-five children using two national representative surveys. Furthermore, we used robust statistical techniques to assess changes. The study combines three complementary statistics techniques (trends analysis, decomposition and fixed effect regression models).
- The major limitation of this study is potential data quality issues since data were collected in the conflict and postconflict contexts. Indeed, the significant observed decrease in diarrhoea prevalence in the DRC contrasts with the generalised poor living conditions of the population.
- Another limitation of the study is the way in which diarrhoea was ascertained. It is self-reported and not determined by a medical examination of trained medical staff. Therefore, the respondent may be subjected to recall bias or misinterpretation of symptoms.

INTRODUCTION

Diarrheal disease is the second leading cause of death among children under five globally. About 22% of childhood deaths in developing countries are attributable to diarrhoea.[1–3] It kills more young children than AIDS, malaria and measles combined.[3]

Diarrhoeal diseases are associated with poverty and unhygienic environments.[3–5] This probably explains the high prevalence of diarrhoea among children whose mothers did not attend school and/or among children living in poorest households particularly in sub-Saharan Africa and South Asia.[3]

With about 1% of the global population, the Democratic Republic of Congo (DRC) has the third highest diarrhoeal morbidity among under-five children and the fifth highest under-five death rate worldwide.[3 6] About 13% of child deaths are diarrhoea related, approximately 60 450 deaths due to diarrhoea in 2010.[7]

However, recent data from national reports show a decrease in childhood diarrhoea prevalence from 2001 to 2010. The prevalence of children with diarrhoea decreased from 22% in 2001[8] to around 17% in 2007 and 2010.[9 10]

Intuitively, the decrease in the prevalence of diarrhoea could be explained by: (1) public health improvement globally or selectively among some specific households and/or (2) increase in the proportion of children living in households with access to water, sanitation and hygiene (wealthy household, living in urban areas, whose mothers have secondary education or higher). The question of substantive interest in this context is: how much of the change is actually due to the improvement of public health suggesting the actual decrease in diarrhoea prevalence and how much is due to a compositional change in the population distribution, especially by maternal education, access to clean water and sanitation, household wealth index?

Against this background, this study aims to analyse diarrhoea prevalence by maternal education, access to clean water and improved sanitation and household wealth index. The study will also identify the sources of variation of diarrhoea prevalence in the DRC, and assess the contribution of each factor in the decline of diarrhoea prevalence. To our knowledge, this is the first study of its kind in the DRC as only some descriptive survey reports,[8–11] and few systematic studies have analysed trends and factors that influence the prevalence of diarrhoea among young children in the DRC.[12]

DATA AND METHODS

Data

This study uses two successive nationally representative household surveys: the 2001 Multiple Indicators Cluster Survey (MICS) and the 2007 DHS. During the 2001 MICS data collection from 21 May to 28 August 2001, three provinces were entirely under the control of the government (Kinshasa, Bas-Congo and Bandundu), four were partially administrated by rebels (Equateur, Katanga, Kasai-Oriental and Kasai Occidental) and four were entirely controlled by rebels (Oriental, Nord Kivu, Sud Kivu and Maniema). Though the 2007 DHS was carried out after the 2006 elections (2 February–30 April 2007 for Kinshasa, and from 10 May–31 August 2007 for the remaining provinces), some villages and municipalities in the Eastern provinces of Nord-Kivu, Sud-Kivu and Oriental were under armed conflict.

The two datasets have comparable information on household characteristics and child diarrhoea at the time of the survey. The sample design and questionnaire are described elsewhere.[8 9] Consequently, the two surveys offer the opportunity of analysing change in diarrhoea prevalence in the DRC. In total, the 2001 MICS database includes information about 8600 households and 9748 under-five children, whereas the 2007 DHS database had information about 8886 households and 7987 children.

For each child under the age of five, the survey respondent in the household was asked whether the child has had diarrhoea in the past 2 weeks prior to the surveys as indicated in the Box 1 and in French language.

Box 1 Question on diarrhoea among under-five children

1. 2001 MICS: ((*Nom de l'enfant*) a-t-il/elle eu la diarrhée au cours des 2 dernières semaines, c'est-à-dire, depuis (*jour de la semaine*) de l'avant dernière semaine ? in French). *Has (name of the child) had diarrhoea in the last 2 weeks, that is, since (day of the week) of the week before last.*
2. 2007 DHS:((Nom de l'enfant) a eu la diarrhée au cours des deux dernières semaines? In French) '*Has (name of the child) had diarrhoea in the past 2 weeks?*

Therefore, diarrhoea is determined not by medical examination but it is self-reported by the mother or caretaker with symptoms of three or more loose or watery stools per day or blood in stool.

Variables

Exposure to diarrhoea-causing agents is frequently related to the use of contaminated water and to unhygienic practices in food preparation and disposal of excreta. Poor sanitation, lack of access to clean water and inadequate personal hygiene are responsible for an estimated 90% of childhood diarrhoea.[3–5 13]

Exposure variables for this study include maternal education, access to clean water and sanitation and household wealth index. A large body of empirical work has shown association between these variables and the prevalence of diarrhoea among under-five children.[3 12–18]

We define clean water or drinking water as water of sufficiently high quality that can be consumed or used with low risk of immediate or long-term harm. It is drawn from an improved drinking water source protected from outside contamination, in particular from contamination with faecal matter including piped water (into residence or plot), public tap, tube well, protected dug wells and protected springs.[19 20] An improved sanitation facility is defined as one that is likely to hygienically separate human excreta from human contact: public sewer, septic tank, pour-flush latrine, pit latrine with slab, ventilated improved pit and ecological sanitation.[19 20] The MICS and DHS surveys collecting these variables use the same definition and categorisation.[21 22]

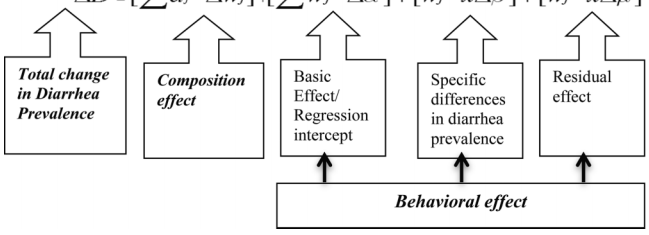
In this study, household wealth index is measured with an asset index and wealth quintile constructed using the statistical Procedure Principal Component Analysis developed by Filmer and Pritchett.[23] The index measures economic status based on housing characteristics, household assets and possession of household consumer durables as well as access to clean water and improved sanitation. The 2001 MICS and 2007 DHS have collected these data. Using rank methods, households are classified by quintile of wealth.

Statistical methods

This study uses three complementary methods: trends analysis, decomposition and longitudinal multivariate models (fixed effect regression models). The Stata, 'nptrend' command performs a non-parametric test of trend for the ranks across ordered groups. The test is an extension of the Wilcoxon rank-sum test.[24] The test provides Z statistics and p value showing whether the change is statistically significant or not.

The decomposition approach divides the trends in child's diarrhoea prevalence into change in population structure and change in health behaviour and/or public health over the study period.[25 26] This method assumes that the historical change in child diarrhoea prevalence depends on: (1) trends in distribution of under-five children by access to clean water and improved sanitation facility, household wealth index and maternal education over time (composition effect); (2) actual change in diarrhoea prevalence due to change in health behaviour or improvement in public health (the basic effect) that is the regression intercept when x=0 (α); (3) variation of diarrhoea prevalence by exposure variables (β), and the residual effect of other variables not considered as e error term (μ). This change can be presented as follows:

$$\Delta D = [\sum \bar{d}_j * \Delta w_j] + [\sum \bar{w}_j * \Delta \alpha] + [w_j * x\Delta\beta] + [w_j * x\Delta\mu]$$



The decomposition analyses are performed at an aggregated/cluster level (the national level by maternal education and household living conditions).

Finally, we use a fixed-effect regression model to explore the relationship between women education and modern contraceptive use within the country. The equation for the fixed effects model is displayed below:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + \mu i_t$$

where

- α_i (i=1...n) is the unknown intercept for each entity (n entity-specific intercepts);
- Y_{it} is the dependent variable (diarrhoea prevalence) where i=children and t=time;
- X_{it} represents the independent variable (child' age, province of residence, household living conditions);
- β_1 is the coefficient for the independent variable (maternal education, access to clean water and sanitation, and household wealth index);
- μ_1 is the error term.

To perform the fixed effect models, we constructed three independent panel datasets (maternal education, access to clean water and improved sanitation and household wealth index). Each dataset has multiple observations about each category of the independent variable considered as individual (number of surveys, two in our case). Therefore, the maternal education database contains six observations, while numbers of observations for the access to clean water and improved sanitation and the household wealth index database are, respectively, estimated at 8 and 10 observations; each database contains the following information proportion of under-five children, year of survey and diarrhoea prevalence.

RESULTS

Sample description

Table 1 presents the distribution of under-five children by selected background characteristics in each sample.

Table 1 Background characteristics of under-five children in DRC (2001 and 2007)

	2001 MICS		2007 DHS	
	Per cent	Number	Per cent	Number
Child sex				
Male	49.8	4855	49.5	3956
Female	50.2	4893	50.5	4031
Child age in months				
0–5	11.1	1070	11.5	919
6–11	11.3	1090	10.8	865
12–23	22.3	2162	20.4	1632
24–35	19.2	1864	19.8	1582
36–47	17.6	1709	19.0	1519
48–59	18.5	1792	18.4	1470
Access to clean water and sanitation				
None	11.8	1153	13.0	1039
Water only	6.7	654	1.4	111
Toilet only	41.1	4008	57.6	4604
Water and toilet	40.4	3933	28.0	2233
Place of residence				
Urban	35.4	3446	41.1	3282
Rural	64.6	6302	58.9	4705
Province of residence				
Kinshasa	13.9	1352	10.7	852
Bas-Congo	5.3	515	7.4	590
Bandundu	11.9	1162	9.2	734
Equateur	11.4	1107	9.9	789
Orientale	10.0	974	7.1	567
Nord-Kivu	7.3	708	8.7	691
Maniema	6.1	593	9.2	736
Sud-Kivu	2.6	253	8.9	710
Katanga	11.3	1100	9.6	766
Kasai Oriental	10.9	1058	10.3	826
Kasai Occidental	9.5	926	9.1	726
Maternal education				
None	27.5	2680	23.9	1909
Primary	41.2	4015	42.2	3369
Secondary and high	31.3	3053	33.9	2709
Household Wealth Index				
Poorest	20.0	1953	22.0	1759
Second	19.5	1903	20.2	1609
Middle	19.6	1911	19.5	1555
Fourth	19.3	1877	20.9	1669
Richest	21.6	2104	17.5	1395
Total	100.0	9748	100.0	7987

Source: 2001DRC-MICS; 2007 DRC-DHS.
Note: Sometime N<total due to missing values.
DHS, Demographic and Health Surveys; DRC, Democratic Republic of Congo; MICS, multiple indicators cluster survey.

The database contains information on 9748 children from the 2001 MICS and 7987 children from the 2007 DHS. The characteristics of under-five children shown in table 1 reveal differences in structure across surveys except if one considers child' age and sex. For instance, the proportion of children living in households with access to clean water and to toilets decreased from 40% in 2001 to 28% in 2007. Moreover, the proportion of under-five children by province of residence varies across surveys. In 2001, the largest proportion of children sample was from Kinshasa (14%) and in 2007 a large proportion of children came from Kasai Oriental and Kinshasa.

Trends in diarrhoea prevalence in the DRC

Table 2 describes trends in diarrhoea prevalence in the DRC from 2001 to 2007.

There is a decrease in the prevalence of diarrhoea. Overall, the prevalence of diarrhoea in the DRC declined by 26% (Z=−9.7, p<0.000) from 22% in 2001 to 16% in 2007. However, this decrease in diarrhoea prevalence is not statistically significant among children who reside in households with water alone without toilet (Z=−1.46, p=0.143).

Decomposition of diarrhoea prevalence changes in the DRC

We decompose changes in diarrhoea prevalence by maternal education, housing living conditions and household wealth index. This may contribute to the understanding on how the observed changes relate to variations in the survey population structure or to changes in public health and/or changes in behaviour. Table 3 presents results of the decomposition analysis.

Table 2 Prevalence of diarrhoea among under-five children in DRC, 1995–2007

	Year		Variation (%)	nptrend test	
Background variables	2001 1	2007 2	2001–2007 3	Z	p Value 0.000
Maternal education					
None	22.5	15.8	−30.0	−4.24	0.000
Primary	22.9	18.9	−17.4	−5.29	0.000
Secondary and+	20.8	13.9	−33.4	−7.50	0.000
Water and sanitation					
None	25.8	18.2	−29.3	−4.14	0.000
Water alone	23.4	19.5	−16.8	−1.46	0.143
Toilet alone	21.4	16.2	−24.2	−5.96	0.000
Water and toilet	21.6	15.9	−26.7	−6.46	0.000
Household wealth index					
Poorest	20.8	17.0	−18.2	−2.12	0.030
Second	24.9	15.7	−37.0	−6.08	0.000
Middle	23.4	16.2	−30.6	−5.65	0.000
Fourth	23.3	18.3	−21.5	−4.82	0.000
Richest	18.7	14.4	−22.8	−3.99	0.000
Total (DRC)	22.1	16.4	−25.8	−9.74	0.000

Source: 2001DRC-MICS; 2007 DRC-DHS.
Variation (3)=((Prevalence in 2007/Prevalence in 2001)−(1))×100.
DHS, Demographic and Health Surveys; DRC, Democratic Republic of Congo; MICS, multiple indicators cluster survey.

Table 3 Decomposition of trends in diarrhoea prevalence in the DRC 2001–2007

	Behavioural effect					
	Base B1	Differentiation B2	Error B3	Total B	Effect of composition A	Contribution C
Maternal education						
None	−1.422	0.000	−0.243	−1.665	−0.764	43.4%
Primary	−2.317	−0.079	0.792	−1.604	0.149	26.0%
Secondary and+	−1.837	−0.125	−0.314	−2.277	0.566	30.6%
Overall	99.7%	3.6%	−4.2%	99.1%	0.9%	100.0
Water and sanitation						
None	−0.732	0.000	−0.349	−1.081	−0.447	27.3%
Water alone	−0.108	0.007	0.087	−0.014	−0.526	9.7%
Toilet alone	−3.201	0.438	−0.580	−3.343	0.945	42.8%
Water and toilet	−1.149	0.236	−0.169	−1.082	−0.050	20.2%
Overall	92.7%	−12.2%	18.0%	98.6%	1.4%	100.0
Household wealth index						
Poorest	−1.425	0.064	0.588	−0.773	0.499	4.9%
Second	−1.340	0.120	−0.605	−1.825	0.226	28.6%
Middle	−1.302	0.176	−0.245	−1.371	−0.038	25.2%
Fourth	−1.337	0.240	0.109	−0.988	0.323	11.9%
Richest	−1.270	0.286	0.185	−0.799	−0.845	29.4%
Overall	119.4%	−15.8%	−0.6%	103.0%	−3%	100.0

Source: 2001DRC-MICS; 2007 DRC-DHS.
DHS, Demographic and Health Surveys; DRC, Democratic Republic of Congo; MICS, multiple indicators cluster survey.

In general, decomposition results indicate that changes in actual diarrhoea prevalence and/or health behaviour are the principal source of decline in diarrhoea prevalence between 2001 and 2007 regardless of the exposure variable (table 3, column B). The analysis of behavioural effect (table 3, columns B1–B3) suggests that the observed decline in diarrhoea prevalence is global (not specific to some socioeconomic characteristics). In other words, the observed changes are due to the general improvement in health behaviour in the DRC. The differentiation effect, the error terms and the composition effect are negligible.

Table 3 (column C) shows also the contribution of each socioeconomic category in the overall decrease of diarrhoea prevalence in the DRC between 2001 and 2007. Depending on the independent variable, decline in diarrhoea prevalence in the following groups have contributed more to the observed changes: Children whose mothers did not attend school (43%), among children who live in household with toilet but without access to clean water (43%) and among children living in the richest households (29%) and children living in the poorer households (29%) have contributed more to the diarrhoea decrease in the DRC between 2001 and 2007. In contrast, small contributions to the overall changes in diarrhoea prevalence are observed from children living in household with 'water alone without toilet' (10%) and from children who stay in poorest households (5%).

Fixed effects of trends in proportion of child's age, province of residence and household's living condition on trends in prevalence of diarrhoea in DRC

Table 4 displays results from fixed effects models. Overall there are no significant changes in diarrhoea prevalence associated with a variation of the population structure by maternal education, household access to clean water and sanitation as well as by household wealth index.

Table 4 Fixed effect of changes in proportion of children by selected characteristics on changes in diarrhoea prevalence in DRC

	β	Constant	Σ_u	Σ_e	ρ
Change in proportion of children per maternal education	−0.1052	15.626	1.478	5.203	0.070
Change in proportion of children per living condition (access to clean water and sanitation)	−0.008	20.446	1.573	4.699	0.101
Change in proportion of children per household wealth index	−0.1546	22.363	1.691	4.922	0.106

Source: 2001DRC-MICS; 2007 DRC-DHS.
***p<0.01; **p<0.05; *p<0.1.
DHS, Demographic and Health Surveys; DRC, Democratic Republic of Congo; MICS, multiple indicators cluster survey.

However, differences across years explain 7% of the variance in the distribution by maternal education, and about 10% if one considers under-five children's distribution by access to water and toilet and household wealth index, respectively.

DISCUSSION AND CONCLUSION

This study had a threefold objective. The first was to describe diarrhoea prevalence trends in the DRC, the second was to identify sources of observed changes in diarrhoea prevalence and the third was to assess the contribution of different categories to the observed changes. Exposure variables included maternal education, access to clean water and improved sanitation, and household wealth index. The study used data from the DRC 2001 MICS and 2007 DHS surveys.

Findings from the three complementary statistical methods (trend analysis, decomposition analysis and fixed effect regression models) are consistent. The significant decrease in diarrhoea prevalence observed in the DRC between 2001 and 2007 is regardless of socioeconomic characteristic and the results from trend analysis corroborate the absence of a composition effect revealed by the decomposition as well as no significant changes in diarrhoea prevalence associated with variation of the population structure (results from the fixed effect regression models). Likewise, these results support the decrease in under-five mortality observed in the country since 2001: 213/1000 live births in 2001[8] and 158/1000 live births in 2010.[10]

Furthermore, children of mothers who never attended school, those living in households with toilet alone (without water) and children living in the poorer (second quintile) households as well as those living in the richest households have contributed more than other children to the observed decline in diarrhoea prevalence.

However, the decrease in diarrhoea prevalence in the DRC as well as the decline in child mortality contrast with the generalised humanitarian crisis, deterioration in environmental conditions and population poverty observed in the country in the same study period. The country is among the lowest-ranked nations in the 2011 Global Peace Index (148th of 153 countries).[27] Since 1996, the DRC has been hit by conflict, which has devastated and destabilised the country. People continue to live in crisis conditions in many parts of the country. The eastern provinces (Orientale, Katanga, Maniema, Nord Kivu and Sud Kivu) are afflicted by violence.

Moreover, the DRC's 2010 Human Development Index (HDI) is estimated at 0.239, which gives the country a rank of 168 of 169 countries with comparable data despite numerous natural resources.[28] Overall, the majority of people do not have access to clean drinking water (54%) and improved sanitation (77%).[13] With reference to data used in this study, the proportion of children living in households with access to clean water and improved sanitation diminished from 40% in 2001 to 28% in 2007.

Two hypotheses could explain the observed discrepancies between the living conditions and changes in diarrhoea prevalence in the DRC. First, there may be some real improvement in health behaviour, particularly the use of boiled drinking water and adequate washing of hands after contact with adult and child stools. However, we cannot test such hypothesis because of lack of data.

Second, there may be some issues with data quality. In conflict situations, it might be very difficult to collect reliable data. For instance, during the 2001 MICS, in the Eastern part, often interviewers had to stop their work and resume after several days. Rebels arrested a fieldworker for more than 6 weeks (MICS2) (8). Furthermore, diarrhoea prevalence is based on self-reporting. Mothers or caregivers can mis-declare diarrhoea prevalence according to her understanding of diarrhoea definition in the local language. Also, duration of data collection varies considerably by province (1 month in Kinshasa and about 2 months in Nord-Kivu and Katanga for the 2001 MICS). In addition, the distribution of children by some socioeconomic characteristics varies across survey. This is probably due to the use of an old national sampling frame from the 1984 Census. However, the methods used (decomposition and fixed effect regression models) control for variation in proportion during analyses.

In conclusion, childhood diarrhoea remains a public health problem in the DRC despite the observed decline. It is noteworthy that the overall significant decrease in diarrhoea prevalence in the DRC is in contrast to the poor living conditions observed in the same period. Our study suggests further studies at the district or province levels to validate findings from national household surveys such as DHS and MICS considering the conflict context of the country when these data were collected and the continuing degradation of the country's socioeconomic and transport infrastructure and security. We hope that the next census in preparation will provide a more comprehensive sampling frame. However, improvement in access to clean water and improved sanitation will contribute to accelerate reduction of diarrhoea prevalence as well as reduction of child mortality.

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KNB participated in conception and design, interpretation of results, critical revisions for important intellectual content and approval of final article for submission.

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