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Research Article

Co-existence of High Levels of Undernutrition and Hypertension among Sabar Males of Purulia, West Bengal, India: A Paradox

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Abstract

Background: Undernutrition, particularly Chronic Energy Deficiency (CED), among tribal males is a major health problem in India. In the recent years, prevalence of Hypertension (HT) is increasing among them. Our cross sectional study assessed the nutritional status as well as prevalence of HT and compare the association of different anthropometric and blood pressure (BP) variables with age among Sabar adult males of Purulia District, West Bengal, India.

Research Methods: Measurements of height, weight, hip and waist circumferences, systolic and diastolic blood pressure, and pulse rate of 215 adults aged 18-63 years were taken following standard procedure and calibrated machines. Body Mass Index (BMI), Waist-Hip Ratio (WHR), Waist-to-Height Ratio (WHtR), Conicity Index (CI) and Mean Arterial Pressure (MAP) were calculated. The ANOVA and Chi Square tests and correlation analysis were performed to test for significant differences and association between variables. Statistical significant was set at 0.05.

Results: The coexistence of high prevalence of undernutrition based on BMI (CED = 47.0%) and HT (37.7%) among adult male Sabars was observed.

Conclusion: Paradoxically, there existed a high prevalence of CED and HT among Sabar men. Further research is required to fully understand the mechanism behind this paradox. Apparently, this population seems to suffer from a double burden of high CED and HT. Similar studies should also be undertaken among other tribal populations (both men and women) to determine whether such a paradox exists among them.

Keywords: *Sabar; Body Mass Index; Chronic Energy Deficiency; Blood pressure; Hypertension.*

Introduction

For the last couple of decades, the evaluation of undernutrition or Chronic Energy Deficiency (CED) has been a major concern for researchers worldwide. Previous studies suggest that CED of women during pregnancy can lead to low birth weight babies as well as result in adverse health implications such as increased risk for diseases, physical retardation, impaired cognitive capabilities and enhanced risk of maternal mortality (Black *et al.*, 2008; Dharmalingam *et al.,* 2010; Singh *et al.,* 2011). Prolonged energy deficiency during young age puts the adult population at a high risk of decreased physical development and

increased incidence of infectious diseases (World Health Organization, 1995) which ultimately leads to decreased work capacity (The World Bank, 2006; Victora *et al.,* 2008). The evaluation of undernutrition is of higher priority because it signifies the lack of food security as compared to obesity which indicates over consumption of food (Letamo and Navaneetham, 2014). In spite of the economic development within the region, undernutrition remains an important public health problem in several Asian countries (Wickramasinghe *et al.,* 2004). Information on the prevalence of undernutrition among adults in developing countries is still lacking among several communities (Scott *et al.,* 2013).

The recent Global Hunger Index (GHI, 2019) ranked India at 102nd position out of 117 countries, even below the neighboring countries such as Pakistan, Bangladesh and Sri Lanka. Undernutrition levels remain higher in India compared to most sub-Saharan countries of Africa despite those countries having lower public health infrastructure, lower levels of economic development and higher infant and child mortality rates (Deaton and Dreze, 2009). Krishnaswami in 2000 stated that more than half of the world's undernourished people live in India. In general, tribal people are the most underprivileged section though they constitute 8.6% of total population of India (Census of India, 2011). Undernutrition has been a major health concern among India tribal populations (Gopalan, 1992; Radhakrishna and Ravi, 2004). A study based on National Family and Health Survey- 3 data reported 47 – 48% prevalence of undernutrition among Indian tribes (Arnold *et al.,* 2009). A recent study on nine tribes from the state of Gujarat, Odisha and West Bengal reported adult undernutrition rates as high as 40% (Kshatriya and Acharya, 2016).

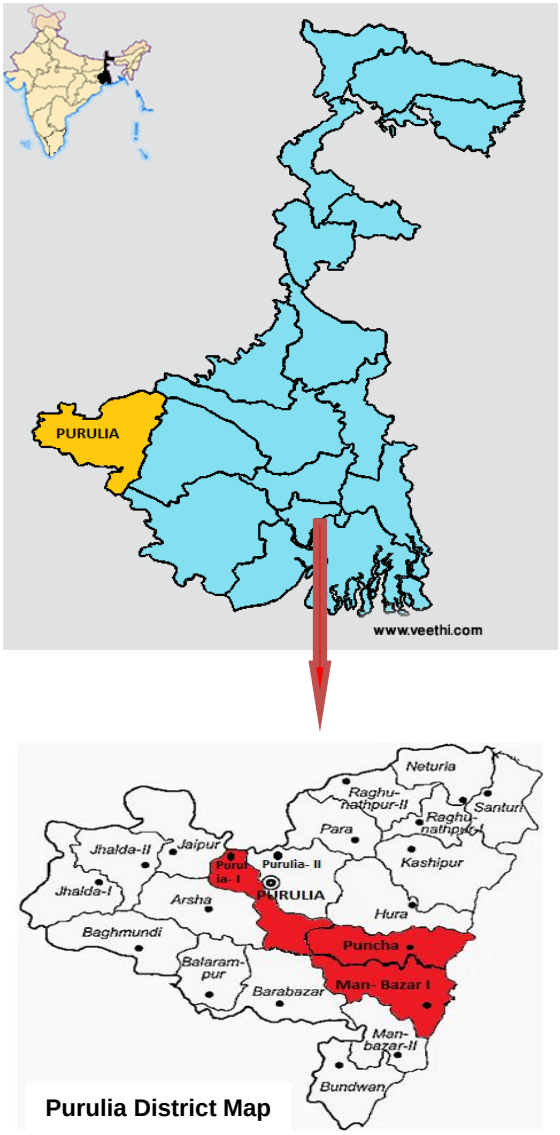
On the other hand, Lima *et al.* (2012) pointed out that the prevalence of high blood pressure (Hypertension, HT) has become the third most important risk factor for the burden on diseases in south Asia. It has been reported on the basis of the analysis of global data on prevalence of HT, that 20.6% of Indian men and 20.9% of Indian women were suffering from HT in 2005 (Kearney *et al.,* 2005). Studies from India in recent years have also revealed similar results (Anchala *et al.,* 2014; NNMB, 2009). Regarding the tribal scenario, results are not much different as Rizwan *et al.* (2014) demonstrated a prevalence rate of 16.1% of HT among Indian tribes. One study from Brazil also reported that early childhood undernutrition may influence the occurrence of HT in adulthood (Sawaya *et al.,* 2005) which makes it more essential to access the HT alongside undernutrition among the marginalized sections like the various tribal populations of our country.

In view of the above, our research was an attempt to assess the nutritional status and prevalence of HT of Sabar adult males of Purulia District, West Bengal, India. We also evaluated the association between anthropometric variables and BP with age.

Materials and Methods

The present study was a community based cross sectional investigation conducted in nine villages from three blocks namely Purulia- I, Manbazar- I and Puncha of Purulia district of West Bengal, India (***Fig. 1***). This district is located at the western part of the state and 225 km away from Kolkata city, state capital. After Jalpaiguri, Purulia has the second highest tribal population. This district is the home to several tribal communities who have their distinct culture, religion, tradition, language and ethnic identity. The total forest coverage in this district is 1857.26 Sq.km which is 29.69% of the total area. Many tribal communities are dependent on these forest produces and one of them is Sabar. During British Raj they were classed as one of the "Criminal Tribe" under Criminal Tribe Act, 1871. After independence under Habitual Offenders Act, 1952 they were declared as "Denotified tribes"/ Vimukth Jati. However, the social stigma of criminality still exists. Traditionally they were foragers but after implementation of national forest policies and wild life protection acts, their entry in forest area is restricted. Separation from their traditional livelihood and uncertain employment opportunities lead to poverty and further marginalization. Presently most of them are working as wage labourers in agricultural

fields, tea plantations, construction of roads, mines etc. According to 2001 census they are the 10th largest tribal group constituting 1% of the total tribal population of West Bengal.



Source:
http://www.purulia.gov.in/images/block.JPG
(Accessed on 10.10.2019)

Figure 1: Location of the study area.

A total of 215 apparently healthy adult males (aged 18-63 years) were selected at random. Necessary permission from the local administration was obtained prior to the commencement of the study. The participants were explained about the objectives of the study and after getting verbal consent data were collected. Anthropometric measurements of height [(HT) (cm)], weight [(WT) (kg)], waist circumference [(WC) (cm)] and hip circumference [(HC) (cm)] were taken following standard methods recommended by International Society for the Advancement of Kinanthropometry (ISAK manual, 2011). Height was measured by Martin's anthropometer and the weight by using a digital weighing machine (Omron HN 289). Waist and hip circumference were measured with a calibrated tape (Gulick Anthropometric tape). Systolic Blood pressure [(SBP) (mmHg)], Diastolic Blood pressure [(DBP) (mmHg)] and pulse rate (PR) were measured using digital blood pressure monitor (Omron HEM-7113).

Body Mass Index (BMI), Waist-Hip Ratio (WHR), Waist-to-Height Ratio (WHtR), Conicity Index (CI) and Mean Arterial Pressure (MAP) were calculated following these formulae:

BMI = Weight (kg) / Height (m^2).

WHR = Waist circumference (cm) / Hip Circumference (cm).

WHtR = Waist Circumference (cm) / Height (cm).

CI = Waist Circumference (m) / 0.109 × √ Weight (kg) / Height (m)
(Valdez *et al.,* 1993).

MAP = Diastolic Blood pressure + (Systolic Blood pressure - Diastolic Blood pressure) /3
(Perusse *et al.,* 1989).

The following standard cut-off values were used to determine the central obesity (CO) for males:

Variables	Normal	Central Obesity	Reference
WC (cm)	≤90	≥90	WHO, 2000
WHR	<0.95	>0.95	WHO, 1989
WHtR	≤0.5	≥0.5	Hsieh and Muto, 2004
CI	≤1.25	≥1.25	Flora *et al.,* 2009

For assessing undernutrition, the WHO cut off points (World Health Organization, 1995) were used. We divided the participants into two groups:

(a) CED (BMI <18.5 kg/m^2) and

(b) Non-CED (≥ 18.5 kg/m^2).

The frequency of HT was determined using the JNC VII classification of BP (Chobanian *et al.,* 2003):

Category	SBP (mmHg)		DBP (mmHg)
Normal	<120	and	<80
Pre hypertension	120 - 139	or	80 – 89
Hypertension Stage 1	140 - 159	or	90 - 99
Hypertension Stage 2	≥ 160	or	≥ 100

All statistical analyses were done by using the Statistical Package for Social Science (SPSS version 16) program. One way ANOVA test was performed to test for significant differences in anthropometric variables between age group categories. Correlation analysis was employed to determine the association between the variables. The Chi square test analysis was performed to test for age group difference in the frequency of CED and HT. Age groups were prepared using percentiles (25th and 50th). The total population was categorized into 3 age groups: Group I: ≤ 29 years, Group II: 30-45 years and Group III: ≥ 46 years for further analysis. A p-value of 0.05 was considered to be statistically significant.

Results

Table 1 shows the descriptive statistics of anthropometric, derived and blood pressure variables of the participants.

Table 1: Age group specific anthropometric, derived and blood pressure variables (Mean ± SD) among the participants.

Variables	Age Group (yrs)			F
	≤29	30-45	≥46	
WC	70.72 ± 6.84	72.16 ± 6.75	69.55 ± 7.16	2.483^{NS}
HC	81.37 ± 5.85	81.67 ± 5.36	78.83 ± 5.29	5.160**
WHR	0.87 ± 0.05	0.88 ± 0.05	0.88 ± 0.05	1.886^{NS}
WHtR	0.44 ± 0.04	0.44 ± 0.04	0.43 ± 0.04	0.976^{NS}
CI	1.15 ± 0.05	1.18 ± 0.05	1.19 ± 0.06	12.513***
BMI	19.72 ± 2.41	19.17 ± 2.45	17.99 ± 2.30	9.267***
SBP	130.41 ± 13.96	132.13 ± 15.47	137.81 ± 26.28	2.792^{NS}
DBP	78.70 ± 9.69	83.76 ± 11.92	84.02 ± 14.44	4.599*
PR	70.38 ± 11.60	76.18 ± 14.62	78.83 ± 17.76	6.072**
MAP	95.93 ± 10.22	99.89 ± 12.64	101.95 ± 17.73	3.533*

Percentages are presented in parentheses; statistically significant at *- p < 0.05, **- p < 0.01, ***- p < 0.001; NS - Statistically not significant.

In case of WC, the lowest mean (69.65 cm) was observed among individuals aged ≥ 46 years while the highest mean was observed in the age group 30-45 years (72.2 cm). Similar results were observed with HC (lowest mean value among the males of age group below 46 years whereas the other two age groups displayed similar means). The mean values of WHR and WHtR were almost similar in all age groups. However, in case of CI, there was a gradual increase in mean with increasing age. In contrast, there was a consistent decrease in mean value of BMI with increasing age (19.72 kg/m^2; 19.17 kg/m^2 and 17.99 kg/m^2). In case of BP variables (SBP, DBP and MAP) there was a gradual increase in mean values with increasing age. One way ANOVA test revealed statistically significant difference between age groups in case at CI, BMI, DBP, PR and MAP.

Table 2: Age group wise distribution of CED among the studied population based on BMI (WHO 1995).

BMI Category	**Age Group (yrs)**			**Total**	χ^2
	≤29	**30-45**	**≥46**		
CED	26 (34.2)	36 (45.5)	39 (66.1)	101 (47.0)	13.762^{**}
Non- CED	50 (65.8)	44 (55.0)	20 (33.9)	114 (54.0)	

Percentages are presented in parentheses; statistically significant at **- p < 0.01.

From ***Table 2***, it can be observed that the prevalence of CED was very high (46.9 %). Out of 101 undernourished males, age groups of 30-45 years (45.5 %) and ≥46 years (66.1 %) demonstrated maximum prevalence of CED. The chi square analysis revealed statistically significant association (p < 0.01) between nutritional status and age groups.

Table 3: Age group wise distribution of Blood Pressure Categories.

Blood Pressure Category	Age Group (yrs)			Total	χ^2
	≤29	30-45	≥46		
Normal	29 (38.2)	27 (33.8)	18 (30.5)	74 (34.4)	2.691^{NS}
Pre-hypertension	21 (27.6)	25 (31.2)	14 (23.7)	60 (27.9)	
Hypertension	26 (34.2)	28 (35.0)	27(45.8)	81 (37.7)	

Percentages are presented in parentheses; NS - Statistically not significant.

Table 3 shows the distribution of HTN of the participants. Overall, 34.4% were normotensive, 27.9% pre-hypertensive and 37.7% hypertensive. Interestingly, higher prevalence of hypertension (45.8%) was found among individuals in age group ≥46 years, whereas maximum males with (31.2%) pre-hypertension were found in age group 30-45 years. The chi square test revealed statistically significant association between HT stages and age groups.

Table 4: Results of correlation analyses.

Variables	Age	HT	WT	WC	HC	SBP	DBP	MAP	PR	BMI	WHR	WHtR	CI
Age		-0.121^{NS}	-0.342^{***}	-0.104^{NS}	-0.213^{**}	0.139^{*}	-0.171^{*}	0.165^{*}	0.231^{**}	0.318^{***}	0.083^{NS}	-0.059^{NS}	0.257^{***}
HT			0.437^{***}	0.122^{NS}	0.339^{***}	0.048^{NS}	0.101^{NS}	0.082^{NS}	0.013^{NS}	-0.034^{NS}	-0.203^{**}	-0.225^{**}	-0.06^{NS}
WT				0.834^{***}	0.877^{***}	0.108^{NS}	0.089^{NS}	0.101^{NS}	-0.184^{**}	0.883^{***}	0.324^{***}	0.667^{***}	0.302^{***}
WC					0.805^{***}	-0.202^{**}	0.222^{**}	0.224^{**}	-0.083^{NS}	0.862^{***}	0.688^{***}	0.939^{***}	0.756^{***}
HC						0.134^{NS}	0.096^{NS}	0.118^{NS}	-0.152^{*}	0.801^{***}	0.126^{NS}	0.675^{***}	0.389^{***}
SBP							0.806^{***}	0.936^{***}	0.003^{NS}	0.095^{NS}	0.182^{**}	0.182^{**}	0.248^{***}
DBP								0.962^{***}	0.163^{*}	0.052^{NS}	0.257^{***}	0.184^{**}	0.33^{***}
MAP									0.908^{NS}	0.074^{NS}	0.235^{***}	0.192^{**}	0.309^{***}
PR										-0.212^{**}	0.055^{NS}	-0.086^{NS}	0.12^{NS}
BMI											0.461^{***}	0.858^{***}	0.365^{***}
WHR												0.744^{***}	0.79^{***}
WHtR													0.763^{***}

Statistically significant at *- p < 0.05, **- p < 0.01, ***- p < 0.001, NS- Statistically not significant.

Results of correlation analysis among studied population are presented in ***Table 4***. Age had a significant negative correlation with weight, HC and positive correlation with MAP, PR, BMI and CI. SBP and DBP had significant correlation with MAP and all CO measures. However, both SBP and DBP did not have any significant association with BMI.

Discussions

Our research was conducted among adult Sabar males of Purulia district of West Bengal to determine the prevalence of CED and HTN. In addition, we also intended to find out the association between anthropometric and blood pressure variables with age. Our study clearly demonstrated the coexistence of high prevalence of CED and HT. Out of 215 adults, 101 (47%) had CED. Maximum CED (66%) was found in the age group ≥ 46 years. The mean value of BMI among the three age groups were 19.72, 19.17 and 17.99, respectively. These values are in good agreement with other studies conducted among tribals across India. The mean BMI of Munda tribal community of West Bengal and Orissa was reported to be 18.65 and 19.11, respectively (Ghosh and Bharati, 2006). Similarly, Khongsdier (2002) reported a mean BMI of 19.18 among War Khasis tribe of North east India was. Overall, half of the total tribal populations studied of central India had a mean BMI below 18.5 which is the cut-off value of CED (Gautam and Adak, 2006). In case of South India, John and Ramadas in 2008 had reported the mean BMI of Mannan males of Kerala to be 20.2. Numerous studies have been conducted on anthropometric characteristics and levels of undernutrition among different tribal communities of West Bengal such as Santals (Ghosh and Malick, 2007), Lodhas (Bose *et al.*, 2008), Bhumijs (Bose *et al.,* 2008), Oraons (Das *et al.,* 2013), Mundas (Das *et al.,* 2013), Koras (Kshatriya and Acharya, 2016). These investigations have demonstrated an alarming prevalence of CED ranging from 45 to 55 %.

Hitherto, the prevalence of CED among the Sabar tribal community of different parts of India has attracted the attention of previous researchers. The comparison of previous investigations dealing with CED of Sabars with the present study is presented in ***Table 5*** (***Fig. 2***). Two studies (Bose *et al.*, 2006; Chakrabarty and Bharati, 2012) were conducted in Orissa, one while one was undertaken in Bankura, West Bengal (Ghosh *et al.,* 2018).

Table 5: Prevalence of CED among Sabar adult males: comparison with other studies on Sabar men.

Sl No.	Studied Area	Sample Size	Prevalence of CED (%)	Reference
1	Keonjhar, Orissa	300	38.0	Bose *et al.,* 2006
2	Cuttack and Khurda, Orissa	106	48.1	Chakrabarty and Bharati, 2012
3	Bankura, West Bengal	111	46.8	Ghosh *et al.,* 2018
4	***Purulia, West Bengal***	***215***	***47.0***	***Present study***

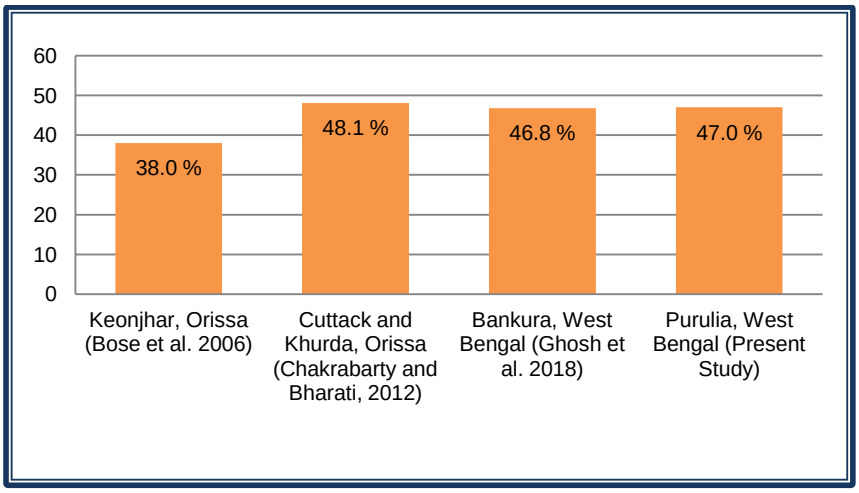


Figure 2: Prevalence of CED among adult Sabar males: comparison with other studies

All the four studies have reported a high prevalence of CED among Sabars. Chakrabarty and Bharati (2012) have reported the highest prevalence of CED (48.1%) followed by the present study (47%). Ghosh *et al.,* (2018) reported a similar prevalence (46.8%). However, Bose *et al.*, (2006) has reported a lower (although still high) prevalence of CED (38%) among Savars of Keonjhar, Orissa.

Interestingly, along with CED, the present study additionally revealed the considerably higher predominance of pre-hypertension and hypertension which is a worrying circumstance among Sabars of West Bengal.

Historically, HT has been associated with overweight and obesity (Díaz, 2002). It has also been linked with metabolic syndrome or Syndrome X (Kshatriya and Acharya, 2016). However, HT has not only been strongly linked with the increased prevalence of overweight/obesity (Díaz, 2002; Chanak and Bose, 2019) but recent studies have also found the association of HT with undernutrition (Sawaya *et al.,* 2005, Ahmed *et al.,* 2018). The overall prevalence of hypertension in India has been reported as 29.8%, including 27.6% and 33.8% in rural and urban areas, respectively (Anchala *et al.,* 2014). A few recent studies have indicated a high prevalence of hypertension among adult tribal populations of India (Chakma *et al.,* 2017; Kandpal *et al.,* 2016).

Hitherto, the tribes of West Bengal have shown a low prevalence of HT ranging between 9% -16.5% (Kshatriya and Acharya, 2016). More specifically, a study conducted by Rao *et al.* (2014) among Savara of Visakhapatnam, Andhra Pradesh has reported a prevalence of HT of only 1.1% which is a contradiction with the present study where 37.7% individuals were hypertensive (***Table 6***).

Table 6: Prevalence of HTN: comparison with other Indian studies (adult males).

Sl No.	Studied Population	Studied Area	Sample Size	Prevalence of HTN (%)	Reference
1	Jenu Kuruba	Mysore, Karnataka	571	28.2	Hatur *et al.,* 2013
2	Savara	Visakhapatnam, Andhra Pradesh	95	1.1	Rao *et al.,* 2014
3	Oraon	West Bengal	112	16.5	Kshatriya and Acharya, 2016
4	Santal	West Bengal	123	9.8	Kshatriya and Acharya, 2016
5	Bhumij	Odisha	116	12.9	Kshatriya and Acharya, 2016
6	Kora	West Bengal	114	10.6	Kshatriya and Acharya, 2016
7	Rural adults	Ghatal, West Bengal	154	27.3	Chanak *et al.,* 2019
8	***Sabar***	***Purulia, West Bengal***	***215***	***37.7***	***Present study***

The prevalence of CED among Sabars is also high as is observed in most of the Indian tribes. Similar to other tribal populations, many risk factors of HT like smoking, chewing tobacco, consumption of alcohol, etc. are also present among Sabars. The majority of the tribals are labourers and generally perform heavy manual work. Concomitant to that, they often have inadequate dietary intake. Hence a considerably high prevalence of CED can be expected among them. What is interesting is the simultaneous presence of a high level of HT. Thus they suffer from a dual burden of high presence of both CED as well as HT. This paradox needs further exploration. Ideally, longitudinal studies are required to fully comprehend the mechanism and aetiology behind this paradox. Such investigations are lacking among Indian tribal populations.

Conclusion

The present study highlighted the coexistence of CED and HT among Sabar males of Purulia District, West Bengal. One of the major limitations of our work was that the design was cross-sectional. Thus, we could not explore the causation behind this phenomenon. In addition to that, the small sample size could be considered another limitation of the present

study but as the studied population was ethnically homogeneous in nature the degree of variability could be expected to be less. However, despite these limitations, our study clearly highlighted an existence of a paradox of both high levels of CED as well as HT. Apparently, this population seems to suffer from a double burden of high CED and HT. Further research is required to fully understand the mechanism behind this paradox. Moreover, similar studies should also be undertaken among other tribal populations (both men and women) to determine whether such a paradox exists among them.

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Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this work.

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