ORIGINAL ARTICLE

High prevalence of hypertension and its selected risk factors among adult tribal population in Central India

Tapas Chakma, Arvind Kavishwar, Ravendra K. Sharma and P. Vinay Rao

ICMR-National Institute for Research in Tribal Health (Formerly Regional Medical Research Centre for Tribals), Jabalpur, India

ABSTRACT

A community based cross-sectional study was carried out to assess the prevalence of hypertension and associated risk factors like salt intake, 24-h urinary sodium excretion and body mass index (BMI) among tribal population of Mandla District, Central India. A total of 3090 individuals, from 1258 house hold drawn from 33 sampled villages and 12 urban wards were studied for blood pressure measurements and clinical examination, while 414 urine samples were collected for estimation of 24-h sodium excretion. Bivariate and multivariate logistic regression were used to assess the associations of BMI, urinary sodium output and other risk factors with hypertension. Across the sample, 28.2% of males and 23.6% of females had either stage-I or stage-II hypertension. More than 8% of subjects <30 years were hypertensive. The prevalence of hypertension shows a strong association with the increase in BMI and tribals with BMI > 25 were considerably more to have high blood pressure. Salt intake is directly related to the hypertension. The prevalence of hypertension was significantly greater among those whose salt intake was more than 10 g per day. A positive association between urine sodium excretion and blood pressure was observed. The results of the present study show that the tribal population is also affected by the life style diseases at par with the non-tribal population.

KEYWORDS

Life style disease;
hypertension; tribal; sodium;
anthropometry; BMI

Background

The Scheduled Tribe (ST) population of India, according to the 2011 census is, 104.3 million, constituting 8.6% of the total population [1]. About 90% of them live in rural areas and only 10% live in urban areas. Broadly the STs inhabit two distinct geographical areas; Central India and North-Eastern India. More than half of the Scheduled Tribe population is concentrated in Central India, i.e. Madhya Pradesh (14.7%), Chhattisgarh (7.5%), Jharkhand (8.3%), Andhra Pradesh (5.7%), Maharashtra (10.1%), Orissa (9.2%), Gujarat (8.6%) and Rajasthan (8.9%) [2]. Madhya Pradesh has a variety of tribal populations reflecting its great ethnic diversity [3]. It is the second largest state in the country. The state has a total tribal population of 15.3 million according to the 2011 census, which is numerically the highest tribal concentration of India. There are 46 scheduled tribes spread over in 50 districts of Madhya Pradesh. Out of these 46 tribes, Gonds are spread over almost all the districts of Madhya Pradesh [2].

High blood pressure is a prevalent condition in all developing countries irrespective of their present stage of health transition and both sexes are affected in large number. A widely spread misconception among the general population about cardiovascular diseases in

developing countries is that these only affect richer persons. However, as the epidemic of cardiovascular disease matures, the disease burden shifts from richer and better-educated segments of a society to the poorer and less educated [4]. In India, hypertension is a leading non-communicable disease (NCD) and estimated to be attributable to nearly 10 percent of all NCD's. The prevalence of hypertension in adults increased over the past 25 years from 5% to 20–40% in urban populations and 12–17% in rural populations [5]. High salt intake has long been thought to play role in development of high blood pressure [6]. Some studies show a positive association between urinary sodium excretion and blood pressure [7]. Studies on hypertension, one of the important risk factor for cardiovascular disorders in rural India are scarce because more importance has been given to infectious diseases in rural and tribal areas. But, because of changes in the life style and environmental factors, the prevalence of hypertension is increasing [6] even among tribals [8]. Most of the reported studies show relationships of obesity and overweight with hypertension but have not examined the association between hypertension, the pattern of salt intake pattern, and 24-h urinary sodium excretion. Only a few studies reported the association of low BMI with hypertension [9,10]. Hence the present

study was planned to study the prevalence of hypertension and to measure its association with selected risk factors like BMI, salt intake and urinary sodium excretion among the adult tribal population by choosing a high Tribal concentration district Mandla of Madhya Pradesh state of India.

Methodology

Study area

Mandla is a tribal district situated in the east-central part of Madhya Pradesh. The district lies almost entirely in the catchment of the river Narmada & its tributaries. It is located between the 22° 43' N, 80° 35' E. The extreme length of the district is about 133 km from north to south and extreme breadth is 182 km from east to west. It covers a total area of 5800 Sq km which is 1.9% of the total area of the state. It has a total population of 1 million of which 57.9% are tribals. There are 6 sub-district divisions (Tehsils), 9 development blocks. According to last population census 2011, Mandla districts has 1203 villages and 25 urban wards in Mandla city. Total population of districts was enumerated as 1,054,905 in the census 2011 and 88% population was residing in rural areas. Approximately 58% of total population was classified as scheduled tribes (STs) and most of these tribals were residing in rural areas. The total literacy rate of Mandla district is 66.9% and the female literacy rate of the district is 56.4%. With an overall sex-ratio of 1008 females per 1000 males, the district is ranked the 3rd best district in the state with respect to the sex ratio. Female work participation of the district is 49.0% of total female and it ranked 2nd in the state in respect to female participation in work [11].

The Gonds are the main tribal community inhabiting in the district. They are of Dravidian origin and can be traced to the pre-Aryan era [2]. The word Gond comes from Kond, which means green mountains in the dravidian idiom.

Design of study and sample size

A cross-sectional survey with two stage sampling methodology was carried out. Using the 'Right Size Statistical software' (CDC Atlanta), we determined that a total of 33 clusters (villages) with a cluster size of a minimum of 20 in each village, an estimate of 50% of the population being affected, with 95% confidence level $\pm 10\%$ confidence interval and a homogeneity rate of 0.3 with a design effect of 6.70, 660 respondents from each group were required. The study was carried out in both rural and urban areas of the district. In rural areas, primary sampling unit was a village, and the village was selected in the first stage by probability proportional to size (PPS) sampling methodology. Twenty households from a selected village were selected by a systematic random selection in the second stage. In the case of urban areas, primary sampling unit was a census ward, and a ward was selected by using PPS sampling technique at first stage. Forty-four households were selected in the second stage by systematic random selection technique in urban area. Out of 1203 villages in the district, 1063 villages were having at least 30 tribal households and only these tribal villages were consider for sampling [11]. The study was conducted in 33 selected villages and 12 urban wards. Rural clusters are divided into two groups, Groups -1 (Tribal villages >15 km from Mandla City) and Group -2 (Tribal villages ≤ 15 km). Group -3 was the wards of Mandla City. But during data analysis, group 1 & 2 are merged and classified as 'Rural' and Group-3 is classified as 'Urban'. The detail sampling is given in the flow chart.

Further, for estimation of sodium level in urine samples, a sample of 67 urine samples was estimated based on the assumption of 95% level of confidence level, 50% prevalence high urine sodium (≥ 260 mmol/L) and 12% absolute error. Thus for laboratory estimations urine samples were decided to be collected from 10% of the respondents i.e. 66 from each group.

Inclusion criteria

All willing adults more than 20 years living at the present address for more than 10 years were included.

Exclusion criteria

People temporarily residing in the area or visitors and guests were excluded from the study. Pregnant women were also excluded from the study.

Ethical clearance

Approval was obtained from the Institutional Ethics Committee of the ICMR -National Institute for Research in Tribal Health (NIRTH), Jabalpur, Madhya Pradesh before initiation of the study. Informed consent was obtained from all the subjects, who participated in the survey. One day's wage was given as compensation to those who gave 24-h urine samples.

All the individuals who were found with high blood pressure were referred to the district hospital Mandla for future management.

Training and standardization

Before the initiation of the survey the Medical officer, Technicians and field workers were trained and standardized at the NIRTH, Jabalpur by the principal investigator of the study. The one-week training programme covered all the techniques of investigation, including measurement of blood pressure and anthropometry. During the training, the emphasis was given to achieve the maximum intra and inter-individual agreement with respect to all the measurements. The teams of field workers also carried out mock surveys during the training. Interview schedules were finalized based on the pilot survey.

Quality control

To ensure the quality of measurements of anthropometry and blood pressure, periodically 5% study participants were re-visited and their anthropometry and blood pressure were measured by the principal investigator in the field as a quality control measure. All the instruments were calibrated every day before taking the readings. About 10% of the laboratory procedures like urinary sodium estimation, serum creatinine, blood urea etc. were tested in duplicate by a senior technician not involved with the routine testing.

Data collection

After obtaining the informed written consent data were collected by field workers through pre-tested semi-structured schedules. Demographic and socioeconomic particulars, such as family size, type of dwelling, age, sex,

occupation, income and literacy level of all the individuals, household possession of agricultural land etc. were collected from all the households selected for the survey. Anthropometric measurements such as height and weight were taken by standard procedure [12] using a SECA digital balance and an anthropometric rod. The nutritional status of adults was assessed according to BMI based on James et al. [13].

Systolic and diastolic blood pressures were measured in sitting posture using a digital sphygmomanometer (Digital Arm BP Monitor HEM-8712, Omron Healthcare India, Pvt. Ltd, Gurgaon, India). This was done for three consecutive reading with a gap of three minutes between each measurement and mean blood pressure was calculated. Before the measurement was taken, the patients were asked to sit comfortably for at least 5 min. Care was taken that arm muscles were relaxed and the forearm supported with the Cubital fossa at heart level. The diet survey was carried out in 10% of the studied households to observe total daily salt consumption using 24-h dietary recall methods [14].

Twenty-four hour urine sample was collected for estimation of urinary sodium. Every individual was given a 2-liter capacity wide mouth jar and requested to stay in the house for the next 24-h and urinate in the given jar. On the first morning of the urine collection, instruction was given to discard the first specimen, and from then on to collect all specimen for up to 24-h, including the first specimen of the following day. One day's wage was given to all the participants to compensate them for their loss of wage. Urine sodium was estimated by a colorimetric method and using the commercially available kit (Accucare urine reagent strips (Catalog No. = URLX 100), Lab-Care Diagnostics Pvt. Ltd., Mumbai, India). This method is based on reaction of sodium with a selective chromogen producing a chromophore whose absorbance varies directly as the concentration of sodium in the test specimen. The range of <0.2 to 260 mmol per liter (mmol/L) was considered normal.

Data analysis

All data were initially recorded on micro computers using Microsoft Office Access, 2007 (Microsoft Corp. WA, USA). Double data entries were done to reduce data entry errors. Statistical analysis was done using IBM SPSS version 20 (IBM Corp., Armonk, NY, USA). Considering both systolic and diastolic blood pressures, the levels of hypertension are categorized as Normal [SBP < 120 and DBP < 80 mm Hg], Pre-Hypertension [SBP (120–139 mm Hg) or DBP (80–89 mm Hg)], Stage-I Hypertension [SBP (120–139 mm Hg) or DBP (90–99 mm Hg)] and Stage-II Hypertension [SBP ≥ 160 mm Hg or DBP ≥ 100 mm Hg]. Levels of hypertension were cross-tabled with age-groups and BMI categories to compare the association. The Chi-square (χ^2) test for trend was used to study the

magnitude of the association between hypertension and age-groups & BMI categories. A binary variable was computed for the hypertension and value labeled as '1' for the stage-I or stage-II hypertension either by systolic or diastolic blood pressure and '0' for the normal/pre-hypertension cases. Using this binary variable both unadjusted (UOR) and adjusted odd ratios were computed using bivariate and multivariate logistic regressions respectively. The critical level of significance was two-tailed $p < 0.05$.

Results

A total of 1258 households from 33 villages/urban wards were covered in the present study. Anthropometric measurements, blood pressure, and clinical examinations were carried out on 3090 individuals while 414 urine samples were collected for sodium estimation.

Approximately 59% of the families were nuclear and 41% were joint families. A majority of the households surveyed lived in *Kachcha* houses (56.3%). Labour (65%) was the main occupation of the head of the households, while only 4.5% households owned agriculture land. More than 17% of households had tap water supply and another 39% houses have hand-pumps. The remaining households were dependent on other sources like open well and rivers or streams.

Table 1. Characteristics of study participants.

Characteristics	Numbers	Percentage
<i>Age groups</i>		
<30	965	31.2
30–39	820	26.5
40–49	736	23.8
50–59	473	15.3
60+	96	3.1
<i>Sex</i>		
Male	1442	46.7
Female	1648	53.3
<i>Literacy status</i>		
Illiterate	833	27.0
Literate	311	10.1
Primary	485	15.7
Middle	510	16.5
High school	538	17.4
Graduate	413	13.4
<i>Marital status</i>		
Married	363	11.7
Unmarried	2531	81.9
Widow/divorcee/separate	196	6.3
<i>Occupation</i>		
Cultivation	92	3.0
Skilled labour	21	0.7
Non-skilled labour	1740	56.3
Petty business	19	0.6
Services	458	14.8
Housewife	430	13.9
Others	331	10.7
<i>BMI</i>		
Underweight	1009	32.7
Normal	1772	57.3
Pre-obese	262	8.5
Obese	47	1.5
Total	3090	100.0

Approximately 31% of participants in the study were less than 30 years and 3% were 60 years or older. The remaining participants were in the 30–59 year age groups. Approximately 53% of the sample were males and 47% were female. About 27% study participants were illiterate and only around 31% had completed high school or higher level education. About 82% were currently married and 12% were unmarried at the time of the survey. More than half (56%) of the respondents were non-skilled labourers and about 15% were engaged in the service sector or small businesses. Approximately one-third of the respondents were underweight and 57% were within the normal range of BMI. Only 8.5% and 1.5% of the respondents were overweight and obese respectively (Table 1).

Approximately 22% individuals had systolic blood pressure greater than 139 mm Hg, while about 19% had diastolic high blood pressure greater than 89 mm Hg. But overall, approximately 26% had high blood pressure (SBP > 139 mm Hg or DBP > 89 mm Hg). About 9% tribal respondents of the study area had stage-II hypertension (SBP ≥ 160 mm Hg or DBP ≥ 100 mm Hg). Approximately 8% study subjects less than 30 years were also observed with stage I or stage II hypertension (SBP > 139 mm Hg or DBP > 89 mm Hg) (Table 2). As the age increased from less than 30 years to 30–39, 40–49, 50–59 and 60 or higher ages, the proportion of stage-II hypertension increased respectively from 1% to 5.5, 11.5, 24.3 and 37.5%. Overall, age-wise distribution of hypertension (χ^2 for trend = 390.9, df = 1, $p < 0.001$) showed a positive association with age in study population (Table 2).

The cross-tabulation of levels of hypertension by BMI shows that about 19% malnourished (underweight) individuals had high blood pressure (stage-I or stage-II hypertension), whereas about 7% had very high blood pressure (stage-II hypertension). But among pre-obese and obese individuals, approximately 43 and 32% had high blood pressure (stage-I or stage-II) respectively, while about 18 and 15% respectively had very high blood pressure (stage-II hypertension). Overall, distribution of hypertension by BMI (χ^2 for trend = 90.2, df = 1, $p < 0.001$) showed a positive association (Table 2).

A significant association between salt intake (gram (g) per person per day) and hypertension level was observed (χ^2 for trend = 1389.5, df = 1, $p < 0.001$). Among those who consumed more than 20 g of salt per day, almost all of them (97%) had high blood pressure (stage-I or stage-II hypertension). The proportion of hypertension increased from approximately 5, 32.4, 82.6 and 96.7% with respect to intake of salt <5, 5–10, 11–15, 16–20 and >20 g per day (Figure 1).

Logistic regression was used to study the association of various risk factors with high blood pressure. High blood pressure is defined as either stage-I/II systolic or stage-I/II diastolic blood pressure, i.e. SBP > 139 mm Hg or DBP > 89 mm Hg. Table 3 shows the prevalence of high

blood pressure and unadjusted and adjusted odd ratios for various risk factors. The unadjusted odd ratio shows that the proportion of high blood pressure increased as age increased, an old tribal individual (60+ years) was about 15 times (UOR = 14.6, 95% CI 9.2–23.3, $p < 0.001$) more likely to have high blood pressure compared to young adults (<30 years). Males were more likely to have high blood pressure as compared to females (UOR = 1.3, 95% CI 1.1–1.5, $p < 0.05$). Individuals with normal (UOR = 1.5, 95% CI 1.3–1.9, $p < 0.001$) and overweight (pre-obese/obese) (UOR = 2.9, 95% CI 2.2–3.8, $p < 0.001$) were significantly more likely to have high blood pressure compared to malnourished (underweight) individuals. Similarly, smokers and individuals with drinking habit were more likely to have high blood pressure. The consumption of table salt (extra salt sprinkled on the cooked

food) and red meat was also associated with increased risk of high blood pressure. Blood pressure increases considerably with increase in total salt consumption, persons with salt intake 10–15 g/day (UOR = 9.4, 95% CI 7.2–12.2, $p < 0.001$) and 15+ g/day (UOR = 147, 95% CI 104–207, $p < 0.001$) were considerably more to have high blood pressure compared to those who consumed less than 10 g/day salt.

However, after adjusting the multivariate logistic regression model for all risk factors significant in bivariate logistic regressions, many risk factors like gender, drinking habit, consumption of table salt and red meat were no longer statistically significant. Nevertheless, even after controlling for all other risk factors, age, BMI, smoking habit and total salt consumption showed significant associations with high blood pressure (Table 3).

Of the 414 samples of 24-h urine collected, about 15% were found with high levels of 24-h urinary sodium excretion (>260 mmol/24-h). Figure 2 shows a significant and positive association of urinary sodium with hypertension. About 71% of individuals with high urine sodium (≥ 260 mmol/24-h) had high blood pressure as compared to 50% among individuals with low urinary sodium excretion (<260 mmol/24-h) individuals. The difference was statistically significant ($\chi^2 = 9.0$, $df = 1$, $p = 0.003$).

Discussion

Various studies conducted in India in the last two decades showed that hypertension is increasing both in urban [15] and among rural communities [16–18]. However, there are very few studies done exclusively among the tribal population. There are also myths that lifestyle diseases are for the rich and urban-dwellers while tribals,

Table 2. Prevalence of hypertension by age groups and BMI categories.

Age groups	Normal	Pre hypertension	Stage-I hypertension	Stage-II hypertension	Total
<i>Age groups</i>					
χ^2 (trend) = 390.9, $df = 1$, $p < 0.001$					
<30	40.8	50.8	7.4	1.0	965
30–39	32.4	45.9	16.2	5.5	820
40–49	25.0	41.2	22.3	11.5	736
50–59	17.5	33.2	24.9	24.3	473
60+	14.6	28.1	19.8	37.5	96
Total	30.5	43.8	16.3	9.4	3090
<i>BMI</i>					
χ^2 (trend) = 90.2, $df = 1$, $p < 0.001$					
Under-weight	40.2	40.5	12.0	7.2	1009
Normal	27.5	45.7	17.4	9.3	1772
Pre-obese	14.5	42.4	25.6	17.6	262
Obese	19.1	48.9	17.0	14.9	47
Total	30.5	43.8	16.3	9.4	3090

Figure 1. Prevalence of hypertension by salt intake.

Table 3. Prevalence of hypertension and odd ratios of risk factors.

Risk factors	Hypertensive ^a (%)	N	Unadjusted OR	Adjusted OR
<i>Age</i>				
<30	8.4	965	1.00	1.00
30–39	21.7	820	3.0(2.8–4.0)***	2.6(1.8–3.7)**
40–49	33.8	736	5.5(4.2–7.3)**	3.6(2.5–5.2)***
50–59	49.3	473	10.6(7.9–14.2)***	4.3(2.8–6.4)***
60+	57.3	96	14.6(9.2–23.3)***	4.1(2.1–7.9)***
<i>Sex</i>				
Male	28.2	1442	1.3 (1.1–1.5)**	1.8(1.4–2.4)
Female	23.6	1648	1.00	1.00
<i>Education</i>				
Illiterate	34.8	833	1.8(1.4–2.3)**	–
Below primary	26.4	311	1.2(0.8–1.7)	–
Primary	21.6	485	0.9(0.7–1.3)	–
Middle	19.6	510	0.8(0.6–1.1)	–
High school	23.0	538	1.0(0.6–1.1)	–
Graduation	23.0	413	1.00	–
<i>BMI</i>				
CED	19.2	1009	1.00	1.00
Normal	26.9	1776	1.5(1.3–1.9)***	1.8(1.4–2.4)***
Overweight	41.0	305	2.9(2.2–3.8)***	4.5(2.9–7.0)***
<i>Smoking</i>				
Not smoking	15.3	2337	1.00	1.00
<5 bidi/cigarette/day	30.1	163	2.4(1.7–3.4)***	2.2(1.3–3.6)**
5+ bidi/cigarette/day	66.1	590	10.8(8.8–13.2)***	5.7(4.2–7.9)***
<i>Smokeless tobacco</i>				
No tobacco	26.8	1035	1.00	–
<5 gm/day	25.0	1005	0.9(0.8–1.2)	–
5+ gm/day	25.5	1050	1.0(0.8–1.2)	–
<i>Drinking habit</i>				
No drinking	20.5	1878	1.00	1.00
Occasionally	33.5	463	1.9(1.6–2.4)***	1.2(0.8–1.7)
Weekly	33.3	619	1.9(1.6–2.4)***	0.7(0.5–1.0)
Daily	38.5	130	2.4(1.7–3.5)***	0.5(0.3–0.9)
<i>Table salt consumption</i>				
Yes	33.3	436	1.5(1.2–1.9)***	1.4(0.9–2.0)
No	24.5	2654	1.00	1.00
<i>Red meat consumption</i>				
Yes	30.0	1388	1.5(1.3–1.7)***	1.1(0.8–1.4)
No	22.3	1702	1.00	1.00
<i>Salt consumption</i>				
<10 gm/day	4.9	1812	1.00	1.00
10–15 gm/day	32.4	751	9.4(7.2–12.2)***	9.4(7.1–12.6)***
15+ gm/day	88.2	527	147(104–207)***	105.5(2.5–153.5)***
Total	25.8	3090	–	R ² = 0.651

^aStage-I or stage -II hypertension.

Note:Significant level *p<0.05; **p<0.01; ***p<0.001.

who have a more traditional lifestyle, do not suffer from lifestyle diseases like hypertension. However, our study showed that tribals are also affected with hypertension, and our findings are similar to findings reported by Laxmaiah et al. from the tribals of Madhya Pradesh and Chhattisgarh [19]. The prevalence of hypertension among the adult tribal population is almost similar to the prevalence reported for rural adults of Madhya Pradesh by the Integrated Disease Surveillance Project survey [20]. About 8% study population less than 30 years were hypertensive, indicating that life style diseases are no more confined to the elder population but affecting the young adult tribal population also. Similar findings were reported from the young adults of United States [21] where age adjusted hypertension was 7.3% among 18–39 years. Reddy et al. from Karnataka [22] also reported 7.2% prevalence of hypertension among 18 to 25 years young adults. Shakya et al. [23] reported rather high prevalence of hypertension from the Mall attending young adults of Nepal. However, the socioeconomic

conditions of the above study groups were entirely different from the population we are reporting.

A prevalence of hypertension 19% among low BMI individuals is a matter of concern. Low BMI has been identified as one of the risk factors for CVD by many researchers [10,24]. Hypertension among a population with low BMI was also reported by Hu et al. [9] from Chinese rural population. Tesfaye et al. [25] also reported similar findings from Ethiopia and Vietnam. Hypertension among Low BMI cases could be due to increased oxidative stress [26] due to reduced bioavailability of nitric oxide as a result of chronic micronutrient deficiency.

The relationship between salt intake and hypertension was established almost 60 years [6,27] back which applies to tribals also [19]. We observed a higher prevalence of hypertension among those who consume salt >10 g/per day, which indicates a positive association of salt intake with hypertension; as the mean salt intake increases blood pressure also increases [6]. Many studies have provided similar evidence that greater salt

Figure 2. Prevalence of hypertension by urine sodium.

consumption is associated with higher levels of blood pressure [27–29]. Since salt intake calculated through 24-h diet survey does not provide value of sodium intake, we studied 24-h urinary sodium excretion as marker of sodium intake and its relation with hypertension. We observed that there is a positive association of 24-h urine sodium with blood pressure; as sodium excretion increases the blood pressure also increases. This trend (χ^2 trend = 7.25, $p < 0.001$) was statistically significant.

Similar to other population, many risk factors of hypertension like smoking, chewing tobacco, consumption of alcohol, and malnutrition etc. are also present among tribals and these are also likely to be part of the causes of the high prevalence of hypertension among tribals. But the majority of the tribals are labourers and generally perform heavy manual work. Hence there was virtually no obesity (BMI > 30) among them. In fact, all the overweight (BMI > 25) tribals included in the study are tribals settled in the urban area. Over all smoking, BMI and high salt intake have emerged as major risk factors for hypertension among the study tribal population.

Hence special intervention programmes are required for prevention and control of hypertension among tribals under the National Health Mission Programme of Government of India addressing the major risk factors.

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Disclosure statement

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