Physical Anthropology 91 - 101

Genetic Sensitivity to Phenylthiocarbamide - Effect on Body Mass Indices and DNA damage

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Abstract

As sensitivity to bitter taste (phenylthiocarbamide [PTC] perception) has been maintained at high frequency worldwide, its use as a potential genetic marker for food preferences and dietary choices and its influence on body weight/adiposity which in turn maybe a contributor to various co-morbidities including malignancy needs to be explored in the Punjabi context where there is higher per capita income, an adapted 'western' dietary pattern with traditional culinary habits and reduced physical activity. Since studies linking PTC tasting status, indices of obesity and DNA damage have not come to attention, the present study, using the alkaline Single Cell Gel Electrophoresis assay was carried out to assess genomic damage in peripheral blood leukocytes (PBL) of 144 individuals, both obese (n=96, as determined by body mass index [BMI] and waist-hip ratio [WHR]) and normal weight healthy (n=46) subjects. Their PTC status revealed 73 tasters and 69 non-tasters. The odds ratio revealed a 2.51 times increased risk in non-tasters (OR=2.51; 95%CI 1.20-5.25) for having BMI≥ 25.0 kg/m² in comparison to risk in tasters while the risk ratio revealed a 1.32 times increased probability of non-tasters for having BMI≥ 25.0 kg/m² in comparison to tasters (RR=1.32; 95%CI 1.05-1.66). The genetic damage in the obese group (characterized on the bases of their gender and PTC tasting ability) was very highly significant (p<0.001) compared to the values in the matched control group (healthy, normal weight subjects). In both the taster and non-taster groups, BMI and WC (waist circumference) significantly correlated to genetic damage indices though PTC tasting ability did not appear to influence BMI, WHR and WC.

Keywords: PTC tasting ability, obesity, comet assay, DNA damage

Introduction

Of the various functional bitter-taste-receptor genes clustered on different chromosomes (Shi *et al.* 2003), *TAS2R38* controls the ability to taste the glucosinolates which are bitter tasting compounds present in *Brassica sp.* The synthetic chemicals, Phenylthiocarbamide (PTC) and 6-n-propylthiouracil (PROP), are major ligands for this receptor (Bufe *et al.* 2005) and taste bitter (tasters) or extremely bitter (super tasters) to ~70/75% of whites (Bartoshuk *et al.* 1994; Tepper and Ullrich 2002; Zhao *et al.* 2003). Allelic or haplotype variation between individuals is probably responsible for the inter-individual differences in taste perception to bitter compounds. Gender differences are also present with females more sensitive to PTC/PROP (Bartoshuk *et al.* 1994) while ageing and oral disease may also influence the phenotypic expression of taste sensitivity (Prutkin *et al.* 2000; Dinehart *et al.* 2006).

In fact a number of studies have shown that preference/avoidance of bitter fruits and vegetables, as well as

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sweet foods, added fats, spicy foods and alcoholic beverages had an association with PTC/PROP taste sensitivity (Dinehart *et al.* 2006; Tepper and Nurse 1997; Keller *et al.* 2002; Duffy *et al.* 2004; Ullrich *et al.* 2004; Bell and Tepper 2006; Yeomans *et al.* 2007) implying that dietary behaviour may be influenced by the ability to taste/not taste PTC/PROP. PTC tasters on one hand are less likely to smoke and on the other to eat less the cruciferous vegetables like broccoli that are important sources of nutrition (Wooding *et al.* 2004). The PROP/PTC tasters also have other oral sensations for example, the PROP tasters perceive more fattiness in foods whereas non-tasters cannot discriminate, they may be eating diets with high fat and / or energy content and consequently be more obese (more weight gain/higher body mass).Hence, genetic taste sensitivity may be responsible for the development of dietary patterns and by extension, weight differences.

In fact, Drewnowski *et al.* (2001) have documented that PROP sensitivity could be protecting against obesity as its tasting was reported to be associated with lower body mass index (BMI). Goldstein and colleagues (2005) also observed higher BMI in non-taster women though cognitive factors had a definitive role in obesity as no association was observed between PROP status and BMI in women with high-dietary restraint while in those with low dietary restraint, a negative association was observed(Tepper and Ullrich 2002). In breast cancer patients also there was found an association between PROP tasting and adiposity (Drewnowski 2004).

Since there is varied distribution of non-tasters and tasters across racial and ethnic groups (Guo and Reed 2001) and as taste sensitivity to PROP/PTC may inherently be altering dietary preferences, it was envisaged to relate PTC-tasting phenotypes to adiposity in the Punjabi population given the rapid nutrition-transition in the state of Punjab correlated with higher per capita income. Further it was thought to correlate the findings with genomic instability since higher BMI and adiposity incite an inflammatory response causing increased generation of reactive oxygen species as well as a depleted antioxidant status causing oxidative stress which can result in oxidative damage to biomolecules including DNA. Increased DNA damage with increase in BMI in breast cancer patients has been reported (Smith *et al.* 2003). DNA damage was also elevated and correlated with severity of heart disease in diabetic- hypertensive and obese individuals (Demirbag *et al.* 2005) and in the metabolite syndrome probably from an imbalance between the production of oxidants and antioxidant defences (Demirbag *et al.* 2006). Recently, the peripheral lymphocytes of obese and overweight children were observed with nuclear damage (Scarpato *et al.*2011). The present study is hence based on the hypothesis that the PTC non-taster phenotype would be associated with higher BMI and waist hip ratio (WHR) and concurrently with higher genomic instability. The significant detrimental outcomes of genomic instability lie in it being an earlier biomarker of a pre-cancerous lesion and so a signal of precocious ageing and neurodegenerative diseases. The Single Cell Gel Electrophoresis (SCGE/ comet) assay in peripheral blood leukocytes is a sensitive technique to assess genomic damage as it can detect double- strand and single- strand breaks and alkali- labile lesions in the DNA of individual cells requiring only few micro liters of blood (Collins 2009). In the present study the alkaline version of the SCGE assay was performed (Singh *et al.* 1988) on 142 individuals (96 obese and 46 normal weight healthy subjects). PTC status was determined using the classic PTC-strip tasting sensitivity. Adiposity was determined as BMI and WHR.

Subjects and Methodology

Subjects

Study subjects comprised healthy volunteers and obese patients from local hospitals. The healthy volunteers had participated during a survey conducted for obesity assessment at Guru Nanak Dev University and a neighbouring colony, Darshan Avenue. Obese individuals undergoing treatment for diabetes and heart diseases at local hospitals also participated in this study. Written informed consent was obtained from all subjects and the protocol was approved by the Institutional Ethics Committee of Guru Nanak Dev University.

Anthropometrical measurements

Body weight (kg) was taken on a standardized weighing machine and height (m) was measured against the wall using a steel tape measure. Waist circumference (WC) was measured midway between the lowest rib and the iliac crest and the hip circumference as the maximum circumference around the hips in centimeters using a tape measure. All measures were taken(Weiner and Lourie 1981) in minimal clothing and without shoes. Body mass

index (BMI) was calculated as body weight in kilograms divided by height in square meters. Waist hip ratio (WHR) as a measure of abdominal/central adiposity was determined by dividing waist circumference by hip circumference. General obesity was determined as per Asian/Indian standards for adult obesity (WHO 2004,Low *et al.* 2009) while the respective cut-off values for WHR and WC in females were 0.80 and 80 cm and 0.90 and 85 cm in males (Snehalatha *et al.* 2003).

PTC tasting

The PTC taste sensitivity was assessed using a filter paper method validated previously in a general survey.The method comprised tasting a filter paper strip impregnated with PTC solution (Ranbaxy Laboratories Ltd., India; 1.3g/l aqueous PTC solution -Whatman No. I filter papers dipped and dried to make the PTC strips). After rinsing their mouths thoroughly, the subjects placed the filter paper strip on the tip of the tongue and rated it either as tasteless or bitter/sour.

Blood collection

Finger-prick blood samples (approximately 200µl) were collected in heparinized eppendorf tubes and placed on ice until they arrived at the laboratory where they were processed for the SCGE assay within 2–3 h.

Cell Viability

Since cytotoxicity produces strands breaks that can be observed as increased DNA migration, it is recommended that the SCGE assay should not be performed on samples showing more than 25% cytotoxicity (Collins 2004). The Trypan Blue Dye Exclusion test was performed on each sample before proceeding for the SCGE assay on samples with ~90% cell viability.

The alkaline SCGE assay (Singh *et al.* 1988)**:** About 30µl of blood was mixed in 80µl of 0.5% LMPA (0.5% low melting point agarose in PBS) and sandwiched between a bottom layer of 1% NMPA (normal melting point agarose) coated on a glass microscope slide and a top layer of 0.5% LMPA. Slides were left to allow the agarose to set at 4°C for ~ 10 min and then given lysis treatment [2.5 M NaCl, 10 mM Tris, 100 mM Na_2EDTA, NaOH to pH 10, and 1% (v/v) Triton X-100] for 1½ - 2 h at 4°C. The slides were then placed in an horizontal electrophoresis tank with 0.3 M NaOH and 1 mM Na_2EDTA, pH 13.0 for 40 min at 4°C followed by electrophoresis for 30 min at 25 V. The slides were then washed thrice with neutralizing buffer (0.4 M Tris-HCL, pH 7.5) before staining with silver nitrate. The slides were coded and scored blindly, first under low magnification (10X) and then at 40X using a binocular microscope (Olympus no: ID00212, model: CH20BIMF 200). Two slides were made from each sample and 50 random cells (25/slide) were scored per individual. DNA migration was measured using an ocular micrometer calibrated with the help of a stage micrometer. The cells were scored as they came into view and overlapping cells were not scored. A quantitative value for DNA damage (DNA migration length) of each cell was calculated as the difference between extent of DNA migration and radius of the nucleoid. The Damage Frequency (DF), which is the number of cells with tails, was also recorded for each individual.

Statistical analysis

SPSS (Statistical Package for the Social Science, SPSS Inc., Chicago, IL) version 16.0 for Windows was used for statistical analyses. Each variable showed normal distribution and so Student's t-test was performed. Results were expressed as mean ± SEM. Pearson's correlation coefficient was carried out to evaluate the correlation of the variables to investigate whether PTC sensitivity influenced BMI, WHR and WC. Analysis was also done to find whether BMI, WHR and WC influenced genomic damage (DNA migration, DF). The odds ratio and risk ratio were calculated for indices of obesity and PTC tasting ability. A value of $P < 0.05$ was considered statistically significant.

Table1. **General and Demographic Information of the Study Group**

Characteristics		Range	Tasters			Non-Tasters		
			Male (n=41)	Female (n=32)	Total (n=73)	Male (n=43)	Female (n=26)	Total (n=69)
Age (y)		16-40	23	15	38	11	14	25
		41 – 65	18	17	35	32	12	44
Height (cm)		145 – 170	26	30	56	31	25	56
		171 – 196	15	02	17	12	01	13
Weight (kg)		40 – 80	25	25	50	19	18	37
		81 – 121	16	07	23	24	08	32
BMI* (kg/m^2)		< 25.0	16	14	30	10	05	15
		≥ 25.0	25	18	43	33	21	54
Waist circumference ** (cm)	Males	< 85.0	02	-	02	01	-	01
		≥ 85.0	39	-	39	42	-	42
	Females	< 80.0	-	06	06	-	03	03
		≥ 80.0	-	26	26	-	23	23
Hip circumference (cm)		81 – 110	36	29	65	32	12	44
		111 – 140	05	03	08	11	14	25
WHR **	Males	< 0.90	19	-	19	06	-	06
		≥ 0.90	22	-	22	37	-	37
	Females	< 0.80	-	07	07	-	01	01
		≥ 0.80	-	25	25	-	25	25
Subjects	Patients	Obese	24	18	42	33	21	54
	Healthy controls	Normal weight	17	14	31	10	05	15
Life style	Alcohol consumption	Yes	02	0	02	09	0	09
		No	39	32	71	34	26	60
	Dietary history	Veg.	24	22	46	24	17	41
		Non-Veg.	17	10	27	19	09	28
	Mobile phone use	Yes	26	21	47	26	08	34
		No	15	11	26	17	18	35
	Excercise	Yes	27	11	38	22	17	39
		No	14	21	35	21	09	30

***** Classified according to WHO(2004); Misra *et al.* (2009); ** Classified according to Snehlatha *et al.* (2003)

Table2. **Gender-Wise Demographic Variables of Subjects**

Characteristics	Group (n=142)					
	Tasters			Non-Tasters		
	Male(n=41)	Female(n=32)	Total(n=73)	Male(n=43)	Female(n=26)	Total(n=69)
BMI(kg/m^2)	27.02±0.80	27.24±1.00	27.12±0.62	28.18±0.75	29.70±1.13	28.75±0.63
WC(cm)	98.30^a±1.79	99.05±3.20	98.63±1.71	103.33**^{a}±2.51	101.86±3.62	102.77±1.65
HC(cm)	99.41^a±1.70	96.50^b±3.20	98.13^c±1.69	105.07*^{a}±1.59	106.70*^{b}±2.93	105.68***^{c}±1.47
WHR	1.00±0.02	1.01±0.03	1.00±0.02	0.98±0.01	0.95±0.02	0.97±0.011

WC-waist circumference; HC- hip circumference; WHR-waist hip ratio; BMI- Body Mass Index
*** Very highly significant ($p<0.001$)** highly significant ($p\leq0.01$),* significant ($p\leq0.05$, Student's t-test)
Values with similar letters are significant for their respective characteristics (waist circumference, hip circumference)

Results

Demographical characteristics of the participants

In Table 1 are described the demographical characteristics of the 142 subjects. Tasters comprised 73 subjects (~51%) and 69 were non-tasters. In the study group, further sub-sets of categories included those who were obese (n= 33), obese-diabetic (n=35), obese with cardiovascular disease (CVD; n=28) and healthy, normal weight individuals (n=46). There were 84 males and 58 females. BMI, HC and WC differences were higher in non-tasters while WHR values were higher in tasters since the HC was higher in non-tasters (Table 2). Among males, the non-tasters had significantly ($p=0.036$) higher central adiposity (WC 103.33cm±2.51 cm) compared to tasters (98.63cm±1.71 cm). For other anthropometric variables, males and females did not show significant

differences regardless of PTC tasting ability.

Table 3. **Risk Ratio and Odds Ratio for indices of Obesity and PTC tasting ability**

Variables			Non-Tasters	Tasters	RR	95%CI	p	OR	95%CI	p
BMI(kg/m^2)		≥ 25	54	43	1.32	1.05-1.66	0.014	2.51	1.20-5.25	0.014
		< 25	15	30						
WHR	Males	≥ 0.9	37	22	1.60	1.77-2.18	0.002	5.32	1.84-15.35	0.002
		< 0.9	06	19						
	Females	≥ 0.8	25	25	1.23	1.00-1.50	0.040	7.00	0.80-61.15	0.078
		< 0.8	01	07						
WC(cm)	Males	≥ 85	42	39	1.02	0.94-1.11	0.530	2.15	0.18-24.70	0.530
		< 85	01	02						
	Females	≥ 80	23	26	1.08	0.87-1.35	0.440	1.76	0.39-7.89	0.450
		< 80	03	06						

p-values in bold are significant (p<0.05); RR-Risk Ratio, OR- Odds Ratio

Table 4. **Genetic Damage in Tasters and Non-Tasters grouped by Gender**

Group		**No.**	**Damage Frequency ±S.E.M. (DF)**	**Mean* DNA migration length (μm)± S.E.M.**
Tasters	Males	41	56.46±5.83	23.05±2.28
	Females	32	50.64±5.37	19.83±1.80
	Total	73	53.83±3.99	21.59±1.49
Non- tasters	Males	43	59.39±6.19	25.75±2.46
	Females	26	70.57±6.09	23.85±2.42
	Total	69	63.60±4.51	25.04±1.44

* Calculated as an average of individual DNA migration lengths in the group.
Non-significance between genders for genetic damage within and between the groups (p<0.05, Student's't'-test)

Table 5. **Genetic Damage in Subjects Characterized on basis of Gender, Obesity and PTC tasting ability**

Group	PTC	*Obese subjects			Controls		
		No.	Damage Frequency ±S.E.M. (DF)	Mean** DNA migration length(μm) ±S.E.M.	No.	Damage Frequency ±S.E.M. (DF)	Mean** DNA migration length(μm) ±S.E.M.
Male	Tasters	24	82.08***±4.023	31.14***±2.009	17	14.00±1.780	11.65±1.622
	Non-tasters	33	78.76***±4.039	32.74***±2.252	10	24.70±8.231	18.63±3.809
	Total	57	76.91***±3.960	29.81***±1.920	27	17.96±4.040	13.07±1.950
Female	Tasters	18	66.72***±6.104	25.27***±2.089	14	26.64±6.179	11.99±2.020
	Non-tasters	21	83.09***±4.042	26.03***±2.568	05	18.00±2.683	1.47±5.083
	Total	39	75.46***±3.580	25.68***±1.600	19	24.36±4.640	12.71±1.94
Total Tasters		42	76.04***±3.660	29.15***±1.697	31	19.71±3.117	11.81±1.253
Total Non- tasters		54	76.59***±4.092	27.34***±1.988	15	22.47±5.517	17.34±2.986

*as per WHO (2004); Misra *et al.*(2009); the group includes only obese, obese-diabetic and obese-cardiovascular disease subjects
** Calculated as an average of individual DNA migration lengths in the group;
*** Very highly significant compared to parallel control group (p<0.001, Student's t-test)

Tasting ability and Obesity

After categorization of tasters and non-tasters for BMI (<25 kg/m^2 and ≥ 25.0 kg/m^2 and), WHR (<0.90 and ≥0.90 for males, <0.80 and ≥0.80 females), WC (<85cm and ≥85 cm males, <80 cm and ≥80 cm females), the risk and odds ratios were computed (Table 3). The risk ratio and odds ratio supported the association of both, general (BMI) and central (WHR)obesity variables with PTC tasting ability. The odds ratio revealed a 2.51 times increased risk in non-tasters (OR=2.51; 95%CI 1.20-5.25) for having BMI≥ 25.0 kg/m^2 in comparison to risk in tasters while the risk ratio revealed a 1.32 times increased probability of non-tasters for having BMI≥ 25.0 kg/m^2 in comparison to tasters (RR=1.32; 95%CI 1.05-1.66). Central obesity measure (WHR) also showed an increased odds ratio i.e. the likelihood of non-taster males was 5.32 times more (OR=5.32; 95%CI 1.84-15.35) for having central adiposity compared to the taster group. The risk ratio of 1.60 (95%CI 1.77-2.18) in male non-tasters also showed the greater probability of being obese than the male taster-group. These results thus suggest an association between various indices of obesity and PTC tasting ability revealing an increased risk of being obese in individuals with PTC non-tasting ability.

Genetic Damage and Tasting ability

On comparing the genetic damage within tasters and non-tasters (Table 4), no statistically significant difference was observed. There were also no gender-based differences in genetic damage within respective groups. However when categorised on the basis of their obesity status (Table 5), the genetic damage in the obese group (only obese, obese-diabetic and obese-cardiovascular disease subjects) was very highly significant (p<0.001) compared to the values in the matched control group (healthy, normal weight subjects), irrespective of gender and tasting ability.

Tasting ability, Obesity and Genetic Damage

In both the taster and non-taster groups, both BMI and WC significantly correlated to genetic damage indices indicating that in subjects with higher BMI and WC values, genetic damage is also higher (Table 6). The negative correlation with WHR in the same taster group requires explanation. However, PTC tasting ability did not appear to influence BMI, WHR and WC (Table 6).

Table 6. **Pearson Correlation Analysis of Obesity Indices with Genetic Damage in Tasters and Non-Tasters and of PTC tasting status with Obesity Indices**

Group	**Variable**	**Mean DNA Migration length**				**Damage Frequency**	
		r		**p**		**r**	**p**
Tasters	BMI	0.490		0.000		0.596	0.000
	WHR	-0.341		0.003		-0.331	0.004
	WC	0.014		0.909		0.117	0.324
Non-tasters	BMI	0.107		0.381		0.455	0.000
	WHR	-0.142		0.245		-0.072	0.554
	WC	0.215		0.076		0.423	0.000
	PTC	**BMI**		**WHR**		**WC**	
		r	**p**	**r**	**p**	**r**	**p**
Females	Tasting Status	-0.081	0.741	-0.226	0.352	0.153	0.531
Males	Tasting Status	-0.056	0.783	-0.046	0.820	0.268	0.177
Total	Tasting Status	0.153	0.069	-0.117	0.165	0.145	0.085

WC-waist circumference; WHR-waist hip ratio; BMI- Body Mass Index p-values in bold are significant (p<0.05)

Discussion

In this study PTC sensitivity, genetic damage and measures of adiposity, both general (BMI) and abdominal (WC, WHR), have been explored. Though BMI and WC were raised in non-tasters, yet only WC in non-taster males was significantly higher than in taster males. On the other hand, WHR was higher but not significantly in tasters and this was related to the fact that the WC and HC values were very similar in the taster group. However, values of HC were significantly higher in non-tasters. Gender differences for BMI, WC,HC and WHR were not apparent. On analysis of OR and RR, an association between various indices of obesity and PTC tasting ability revealed an increased risk of being obese (BMI≥ 25.0 kg/m^2) in individuals with PTC non-tasting ability. Genetic damage indices were also not significantly different between the tasters and non-tasters. However, it needs to be recalled that the participants in this study included healthy controls as well as patients who were obese, obese-diabetic and obese with CVD. On comparison of genetic damage between the values in the control and obese subjects, significantly elevated damage was observed in patients though no gender differences were there. BMI and WC also showed an association with genetic damage. On testing for the effect of tasting status on indices of obesity, correlation analysis failed to demonstrate an association.

The allelic frequency of the 't' allele was 0.70 with ~51% PTC tasters. Frequency of tasters varies in different populations and in India has been reported between 35-78% (c.f. Malini *et al.* 2007). The frequency of the allele also shows wide variation and in India varies between 0.124-0.897 (c.f. Luxmi and Kapoor 2011) being in the range of 0.32-0.63 in people of eastern Uttar Pradesh (Singh and Singh 2011).The taster and 't' allele frequencies in the present group match with those reported.

In the literature although increased genetic damage has been reported in obese subjects but there are disparate reports linking tasting status with obesity. A negative association was observed between PROP tasting and measures of adiposity in elderly women (Duffy *et al.* 2004) though not among breast cancer patients (Drewnowski 2004). However, non-taster women had a higher mean BMI than super-taster women (Tepper and Ullrich 2002; Goldstein *et al.* 2005). The association between tasting status and BMI could be altered by calorific restriction especially as observed among women thereby diminishing the influence of this phenotype on adiposity (Tepper and Ullrich 2002).

Reasoning that non-tasters would have lesser food preferences than tasters, tending to eat more and so have higher weight, the non-taster phenotype should have higher BMI and waist circumference (Keller and Tepper 2004). There were ~ 48.59% non-tasters in the present study and OR and RR showed their increased risk of having higher BMI, and in males, also higher WC. Correlation analysis however did not show any association of BMI with PTC taster status. Villarino *et al.* (2009) also reported no association between BMI and PROP taster status. Tepper *et al.* (2008) reported also higher BMI and WC in non-taster females compared to taster females on low dietary restraint but neither observed any *TAS2R38* haplotype nor PROP phenotype as strongly relating to BMI or WC in males. Cultural dietary patterns and diet types besides cognitive dietary restrictions may be contributors in overriding the genotypic effect on food preferences (Tepper and Ullrich 2002; Mennella *et al.* 2005). Affluence and increased per capita income in Punjab may too be playing such a role in the sample group studied.

Obesity induces an inflammatory response (Hotamisligil 2003) as increased concentration of various inflammatory biomarkers (viz. interleukins, C-reactive proteins) have been documented (Green *et al.* 1994;Hotamisligil *et al.* 1995).Free fatty acids and adipocytokines are released from the visceral adipose tissue inciting a pro-inflammatory response which may result in insulin resistance (Kopelman 2000;Boden 2006). The high-energy low-activity routine is responsible for the increased adiposity thereby triggering inflammation and the generation of free radicals (Curti *et al.* 2011). These reactive species affect the cellular macromolecules with a tendency to damage via the oxidation process. Oxidative DNA damage can have more serious repercussions in terms of malignancy and precocious age-associated alterations (Moller *et al.* 2000).

The association of abdominal obesity, low-grade inflammation and lipid peroxidation can cause DNA damage and contribute to vascular dysfunction. In this study, the obese individuals as well as those with the associated co-morbid conditions had significantly higher genomic damage compared to the normal weight non-obese individuals. The non-significant differences between various co-morbid conditions may well be because the treatment regimens may be protective in action via an anti-oxidant pathway. However the observed increased damage to DNA (higher DNA migration and damage frequency) in all obese subjects compared with normal

weight subjects , if not repaired, may lead to cancer development (Loft and Poulsen 1996). Some recent studies have also documented increase in genetic damage in association with obesity and oxidative stress. Compared to lean persons, oxidative DNA damge was reported in overweight and obese subjects(Al-Aubaidy and Jelinek 2011; Elwakkad *et al.* 2011).Decrease in antioxidants and increased DNA damage was also observed with obesity (Bukhari *et al.* 2010; Wiegand *et al,*2010). Even obese and overweight children had increased chromosomal damage (Scarpato *et al.* 2011) and pre-obese as well as obese women had increased DNA damage (Tomasello *et al.,* 2011).

The analysis of the observations from the present study revealed that the PTC non-tasting ability was associated with an increased risk of being obese (BMI≥ 25.0 kg/m^2); also significantly elevated genetic damage was observed in obese subjects with both, BMI and WC showing an association with genetic damage. These results find consistence in literature relating oxidative stress with nuclear damage in the obese condition and non-tasting status with higher BMI. Fortunately the association between tasting status and adiposity can be changed by cognitive dietary/calorific restriction (Tepper and Ullrich 2002). Therefore maintaining an optimal body weight by balancing energy intake (diet) with energy expenditure (physical activity) can assist in reducing the risks for the development of the metabolic syndrome as well genomic damage and cancer and thereby improve the quality of life.

Acknowledgement: The departmental UGC-SAP research grant provided assistance for carrying out this work.

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