Association Between Household Use of Chlorine Containing Chemicals and Obesity: A Cross-Sectional Study

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Abstract

Studies have shown high prevalence of obesity among Saudi subjects, with the maximum prevalence among married women. Increasing exposure to the industrial chemicals with (endocrine-disrupting chemicals, EDCs) such as household Chemicals Containing chlorine could be a factor contributing to the increased obesity.The study was carried out to determine the association between the use of household chemicals Containing chlorine and the prevalence of obesity among married women living in Almadinah Almonawarra.Cross sectional study including 1019 native healthy Saudi married women were randomly chosen from those attending 20 primary health care centers in Almadinah Almonawara city. Anthropometric examination and full history of using chlorine containing chemicals were done to all subjects.There was highly significant correlation between females body mass index and the use of chlorine containing Chemicals (P=0.002).Conclusion: chronic

exposure to EDCs may be a contributing factor for obesity. More detailed studies are needed to confirm BPA as risk factor for obesity.

Introduction

Studies have shown high prevalence of overweight and obesity among Saudi subjects ***(Al-Nuaim, 1997).*** An epidemiological household survey among 13,177 Saudi subjects, with mean age 33 years (15-95 years), found that there was a progressive increase of Body Mass Index (BMI) for male and female subjects with age, reaching maximum at the 5th decade. The prevalence of obesity was significantly higher in females than in male subjects (24% vs 16%). Overweight and obesity were more prevalent among illiterate, high-income subjects who were residing in urban communities in Saudi Arabia ***(Al-Nuaim et al., 1996).*** The increased caloric intake and decreased physical activities are the major causes of this dra11matic increase. However Increasing exposure to the industrial chemicals with endocrine-disrupting activities (endocrine-disrupting chemicals, EDCs) released into the environment could be another/ factor contributing to the increased obesity ***(Heindel et al,. 2003, Brantley et al .,2005 and Heindelet al., 2007).***

Endocrine disruptors are chemicals, or chemical mixtures, that interfere with normal hormone function. Among these chemicals household detergent chemicals and their byproducts such as polychlorinated biphenyls pen-tachlorobenzene (BPA) can easily vaporize, and inhaling such vapor are toxic and can induce substantial oxidative stress ***(Bronstein et al., 2010)***. Residual of (BPA) often found in chlorine-containing household cleaning (e.g., dishwashing and laundry detergent, and toilet cleaning solution) and

personal hygiene products (e.g., bar soap, body lotion, shampoo/ conditioner, shaving cream) could act as a source for ClxBPA (PBA (formation, when gets in contact with chlorinated tap water ***(Dodson et al., 2012).*** A (BPA) is capable of disrupting endocrine functions through mimicking or blocking endogenous hormones and disrupt the body's normal functions ***(Diamanti-Kandarakis et al., 2009).*** Human's exposure to such chemicals has been associated with increased triglycerides and cholesterol, impaired fasting glucose and diabetes ***(Tang-Péronard et al., 2011).*** Which are capable of changing the body's natural weight control mechanisms thus may lead to obesity, exposure to BPA has already been linked to obesity in animal studies ***(Newbold et al., 2007 and Miyawaki et al., 2007).*** According to the frequent exposure of chlorine containing chemicals and its potential as an EDC and obesity-promoting substance, the goal of this study was to examine the relation of the frequent use of these substances and body weight status among 1019 Saudi married women.

Methodology

Study design: We hypothesized that chlorine-containing cleaning products used in household cleaning activities could be the direct source of BPA via the production of chlorinated BPA (ClBPA) derivatives therefor a cross sectional study was used.

Settings: Outpatient clinics of Ohoud hospital, the medical directory of Taibah University (girls section), Al-Safa hospital and 20 primary health care centers at Al-Mainah Al-Monawara city.

Subjects: 1019 native Saudi married women were randomly chosen from those attending the antenatal care clinics.

Inclusion criteria: Willing to participate**,** absence of systemic diseases or drug intake that are known to cause obesity and all females should be married.

The followings were done:

Anthropometric technique: Weight and standing height were taken for each subject using the standard techniques and BMI for each volunteer was calculated. According to the World Health Organization (2006). The BMI <18.5 indicating underweight, the BMI above 25 indicates that a person is overweight and the BMI above 30 that a person is obese. Body mass index was assessed using the criteria presented in table 1.

Using A structured questionnaire, a face to face interview was done to all participants. The questionnaire included detailed open and closed ended questions about the frequency of use of chlorine and, Comparison between the grades of obesity and the frequency of chlorine use, data were analyzed using the chi-square test. The minimal level of significance set at $P < 0.05$.

Results

Characteristics of participants

The total number of the participants in this study was 1019 and were subjected to anthropometric measurements using the standard techniques. Mean age of the participants was (27.9±6.2) ranges from (16-50) years.

Table 2 represents the distribution of the sample according to education level and the frequency of chlorine containing chemical

use There was no significant difference between the education level and the frequency of chlorine use.

Relation between BMI and the use of chlorine containing chemicals

Table 3 shows the weight status of the participants in relation to the frequency of chlorine use, among (1019) surveyed females; (28.2%) were classified as having over weight, the prevalence of overweight was higher among those who were using chlorine containing chemicals on weekly basis compared to different frequency of use. The overall prevalence of obesity among the participants was (18.8%). Obesity grade 1 was represented by (13.7%) of the sample with higher prevalence among those with weekly use (48.6%) while the prevalence of Obesity grade 2 and 3 was higher among those who were using chlorine containing chemicals on daily basis (38.2%& 44.4%) compared to different frequency of use.

Results in Table 4 demonstrates the mean of BMI of the females who were using chlorine containing chemicals on daily base and those with no use, there was a significant difference in the BMI between the two groups (P=0.02*)

Discussion

Household chlorine containing chemicals and their byproducts as polychlorinated biphenyls pen-tachlorobenzene and (BPA) (which manufactured at high volumes in household products such as personal care products, and surfactants household cleaners) ***(Bronstein et al., 2010)*** have the potential to alter the function of the endocrine system and consequently cause adverse health effects in

humans. ***(Vos et al., 2000).***BPA has been shown to have a positive association with childhood obesity in epidemiological studies ***(Bhandari et al., 2013 and Trasande et al., 2012).***

Results of our cross sectional study indicated that the use of chlorine containing chemical is very common among females visiting outpatient clinics in primary health care centers.Among the studied females, the overall prevalence of overweight and obesity was 47%, represented by (28% over weight, 13.7% obese grade one, 3.3% obese grade 2 and 1.8 obese grade 3), data are clarified in table 3. Our findings indicated that the prevalence of obesity grade 2 and obesity grade 3 increases with the increased exposure to chlorine containing chemicals (daily use) (38.2% and 44.4%) respectively compared to different frequency of use. Moreover, there was a positive significant association between females' body weight status and the use of chlorine containing chemicals (P=0.002).

When referring to studies which have investigated the relationships between BPA concentrations and obesity indicators, the reported results seem to be inconsistent ***(Carwile et al., 2011; Galloway et al., 2010; Lakind et al., 2014; Shankar et al., 2012 and Wang et al., 2012).*** A cross sectional study published by ***(Milić et al., 2015)*** with a comparable result to our results reported that a high concentration of the BPA in urine of the overweight and obese women indicates that higher exposure to BPA could contribute to weight problems in women. His results were reconsidered and the analyzed samples were divided into two groups: normal weight (<24.99 BMI) and overweight/obese (≥25.00 BMI). The cross-section nature of the study and the size of the subgroups that were not large enough might have led to the inability to reach the statistical

significance of the correlation between the urinary BPA and the BMI. However numerous animal studies have demonstrated an association between endocrine disrupting chemicals (including BPA) and obesity ***(Vom et al., 2012).*** But the relationship between BPA exposure and obesity in humans is still unclear ***(Oppeneer, et al., 2015).***

Another study which in agreement with our findings was conducted by ***(Wang et al., 2012)*** and revealed that Urine BPA levels were tightly related to the body mass index (BMI) in school children in Shanghai City, China moreover he concluded that the large amount of different types of EDCs affect lipid metabolism and contribute to the obesity epidemic.

Epidemiological investigations have revealed that BPA exposure is tightly related to bodyweight increase and obesity occurrence. Proposed mechanisms through which BPA exposure can affect body weight were published in previous epidemiological studies which demonstrated that BPA acts as an endocrine disruptor and may have impact on metabolic processes in human organism which directly reflect the association between BPA and obesity and they as: (i) the overweight and obese children and adolescents ***(Metab et al., 2013).*** (ii) the BPA elevated values as a cause of obesity***(Trasande et al., 2012 and Wang et al., 2012).*** It has also been proved that BPA as a potential synthetic estrogen disruptor can suppress adiponectin involved in the regulation of glucose levels as well as fatty acid oxidation, even at low concentration ***(Alonso-Magdalena et al. 2011).***

On the other hand, ***Alonso-Magdalena et al., (2011)*** concluded that there are different effects of BPA exposure during

different stages of development, during adulthood, BPA exposure modifies insulin sensitivity and insulin release without affecting weight. No association was reported between urinary BPA and overweight or obesity in a cross-sectional analysis of Italian adults ***(Galloway et al., 2010).*** or an analysis of 2003–2004 NHANES (National Health and Nutrition Examination Survey) biomonitoring data of the US general population ***Lang, I.A., et al. 2008***. It is wise to mention that the reverse causation is of concern due to the cross-sectional nature of the study ***(Carwile et al., 2011).***

These results, along with previous studies, suggest that this association warrants further investigation, such as a longitudinal study that would allow for long-term exposure to be evaluated and confounder to be taken into the account.

Limitations

This study acknowledges some limitations. First, this was a cross-sectional study which was suitable for evaluating the frequent use of household chlorine containing chemicals, but this design limits the inferences that can be made because all data are collected at a single time-point; therefore, causation cannot be explored. Second, ideally, we didn't measure urinary EDCs including BPA to assess levels of exposure, besides, many cases were dropped out of the sample due to many reasons which affect the sample size of the study. Furthermore, because of using questionnaires, there is the possibility of information bias because of a reliance on participants providing accurate information.

Conclusion

The present study indicated that the use of household chlorine containing chemicals was very common among married women living in Almadina Almonawarra, our results revealed a significant association between the frequent use of such chemicals and the incidence of obesity and obesity grades. More Prospective studies that assess BPA exposure and changes in body weight, estrogenic activity and the potential adverse health effects in humans with the hormonal imbalance is needed.

Table 1: Assessment criteria for body mass index (BMI)

Underweight	<18.5

Normal	18.5 to 24.9
Overweight	24.9 to 29.9
Obesity grade 1	30.0 to 34.9
Obesity grade 2	35.0 to 39.9
Obesity grade 3	> 40

Table (2): Frequency of using chlorine containing chemicals and educational level

Educational level	%	No use (n=)	daily	weekly	monthly
Illiterate(n=32)	3.1	10	10	10	2
Read &write(n=59)	5.8	13	17	21	8
Primary school(n=130)	12.8	29	30	56	15
Preparatory (n=193)	18.9	39	51	84	19
secondary(n=304)	29.8	64	76	127	37
university(n=287)	28.2	70	52	132	33
postgraduate(n=14)	1.4	5	3	3	3
Total (n= 1019)	100	230	239	433	117

Chi-square =16.229, P value=0.56, P≤0.05

Table (3): Statistical comparison of BMI characteristics between females with no and chlorine containing chemicals detailed use

		Chlorine use (n=1019)								%	Chi-square value	P value
		No use		Daily use		Weakly use		Monthly				
		n	%	n	%	n	%	n	%			
BMI	Underweight (N= 82)	22	26.8	15	18.4	38	46.3	7	8.5	8.1	34.408	.002*
	Normal (N= 458)	106	23.1	86	18.8	204	44.5	62	13.6	44.9		
	Overweight (N= 287)	64	22.3	81	28.2	111	38.7	31	10.8	28.2		
	Obese grade (1) (N= 140)	29	20.7	36	25.7	68	48.6	7	5	13.7		
	Obesity grade (2) (N= 34)	6	17.6	13	38.2	8	23.5	7	20.7	3.3		
	Obese grade (3) (N= 18)	3	16.7	8	44.4	4	22.2	3	16.7	1.8		
total	1019	230		239		433		117		100%		

Chi-square =16.229, P value=0.56, P≤0.05

Table (4): Statistical comparison between BMI for females with no and chlorine containing chemicals use on daily base

	No use N=233	Daily use N=243	P value
	Mean ±SD	Mean ±SD	
BMI	24.9972±5.29	26.62±5.82	0.02*
P≤0.05			

References

Al-Nuaim AR, al-Rubeaan K, al-Mazrou Y, al-Attas O, al-Daghari N, Khoja T. (1996):
High prevalence of overweight and obesity in Saudi Arabia. Int J Obes Relat Metab Disord. Jun; 20 (6):547-52.

Al-Nuaim AR. (1997):
Population based epidemiological study of the prevalence of overweight and obesity in Saudi Arabia, regional variation. Ann Saudi Med 17: 195 – 199.

Alonso-Magdalena P, Quesada I, Nadal A. (2011):
"Endocrine disruptors in the etiology of type 2 diabetes mellitus". Nat Rev Endocrinol.7 (6): 346–53.

Bhandari, R. Xiao, J. Shankar, A. (2013):
Urinary Bisphenol A and Obesity in US Children. American Journal of Epidemiology. 177 (11): 1263–1270.

Brantley P.J., H. Myers, H.J. Roy, (2005):
Environmental and lifestyle influences on obesity, J. La. State. Med. Soc. 157 (1) S19–S27.

Bronstein AC, Spyker DA, Cantilena Jr LR, Green JL, et al. (2010):
Annual report of the American Association of Poison Control Center's national poison data system (NPDS): 28th annual report. Clin Toxicol 49:910_41.

Carwile, J.L., Michels, K.B. (2011):
Urinary bisphenol A and obesity: NHANES 2003–2006. Environ. Res. 111, 825–830.

Diamanti-Kandarakis E, Bourguignon JP, Giudice LC, Hauser R, Prins GS, Soto AM, Zoeller RT, Gore AC. (2009):
Endocrine-disrupting chemicals: An Endocrine Society scientific statement. Endocr Rev. 30(4):293–342.

Dodson, R.E., Nishioka, M., Standley, L.J., Perovich, L.J., Brody, J.G., Rudel, R.A. (2012):
Endocrine disruptors and asthma-associated chemicals in consumer products. Environ. Health Perspect. 120 (7), 935–943.

Galloway, T., Cipelli, R., Guralnik, J., Ferrucci, L., Bandinelli, S., Corsi, A.M., Money, C., McCormack, P., Melzer, D. (2010):
Daily bisphenol A excretion and associations with sex hormone concentrations: results from the InCHIANTI adult population study. Environ. Health Perspect. 118, 1603–1608.

Heindel J.J., (2003):
Endocrine disruptors and the obesity epidemic, Toxicol. Sci. 76. 247–249.

Heindel J.J., (2007):
Role of exposure to environmental chemicals in the developmental basis of disease and dysfunction, Reprod. Toxicol. (23) 257–259.

Lakind, J.S., Goodman, M., Mattison, D.R. (2014):
Bisphenol A and indicators of obesity, glucose metabolism/type 2 diabetes and cardiovascular disease: a systematic review of epidemiologic research. Crit. Rev. Toxicol. 44, 121–150.

Lang, I.A., Galloway, T.S., Scarlett, A., Henley,W.E., Depledge, M.,Wallace, R.B., Melzer, D., (2008):
Association of urinary bisphenol A concentration with medical disorders and laboratory abnormalities in adults. JAMA 300, 1303–1310.

Metab. Li, D.K., Miao, M., Zhou, Z., Wu, C., Shi, H., Liu, X., Wang, S., Yuan, W, (2013):
Urine bisphenol-A level in relation to obesity and overweight in school-age children. PLoS One 8 (6), 1-6.

Milić N1, Četojević-Simin D, Milanović M, Sudji J, Milošević N1, Ćurić N, Abenavoli L, Medić-Stojanoska M. (2015):
Estimation of in vivo and in vitro exposure to bisphenol A as food Contaminant. Food and Chemical Toxicology. 83, 268-274.

Miyawaki, J., Sakayama, K., Kato, H., Yamamoto, H., Masuno, H. (2007):
Perinatal and postnatal exposure to bisphenol A increases adipose tissue mass and serum cholesterol level in mice. J. Atheroscler. Thromb. 14 (5), 245–252.

Newbold RR, Padilla-Banks E, Snyder RJ, Phillips TM, Jefferson WN. (2007):
Developmental exposure to endocrine disruptors and the obesity epidemic. Reprod Toxicol. 23(3):290–296.

Oppeneer, SJ; Robien, K. (2015):
Bisphenol A exposure and associations with obesity among adults: a critical review. Public Health Nutrition (Systematic Review). 18 (10): 1847–63.

Shankar, A., Teppala, S., Sabanayagam, C., (2012):
Urinary bisphenol a levels and measures of obesity: results from the national health and nutrition examination survey 2003– 2008. ISRN Endocrinal. 965243.

Tang-Péronard, J.L., Andersen, H.R., Jensen, T.K., Heitmann, B.L. (2011):
Endocrine disrupting chemicals and obesity development in humans: a review. Obes. Rev. 12, 622–636.

Trasande, L., Attina, T.M., Blustein, J. (2012):
Association between urinary bisphenol A concentration and obesity prevalence in children and adolescents. JAMA. 308(11), 1113-1121.

Vom S., Frederick S., Nagel, Susan C., Coe, Benjamin L., Angle, Brittany M., Taylor, Julia A. (2012):
The estrogenic endocrine disrupting chemical bisphenol A (BPA) and obesity. Molecular and Cellular Endocrinology. Environment, Epigenetics and Reproduction. 354 (1–2): 74–84.

Vos, J.G., Dybing, E., Greim, H.A., Ladefoged, O., Lambré, C., Tarazona, J.V., Brandt, I., Vethaak, A.D. (2000):
Health effects of endocrine-disrupting chemicals on wildlife, with special reference to the European situation. Crit. Rev. Toxicol. 30, 71–133.

Wang, T., Li, M., Chen, B., Xu, M., Xu, Y., Huang, Y., Lu, J., Chen, Y., Wang, Li, X., Liu, Y., Bi, Y., Lai, S., Ning, G. (2012):
Urinary bisphenol A (BPA) concentration associates with obesity and insulin resistance. J. Clin. Endocrinol. Metab. 97, 223–227.

World Health Organization. Global Database on Body Mass Index. (2006)

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"العلاقة بين الاستخدام المنزلي للمواد الكيميائية المحتوية على الكلور والاصابة بالسمنة: دراسة عرضية"

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الملخص العربي

أظهرت الدراسات ارتفاع معدل انتشار السمنة بين السعوديين وان معدل الاصابة أعلى بين النساء المتزوجات. ان زيادة التعرض للمواد الكيميائية الصناعية (المواد الكيميائية التي تسبب اختلال الغدد الصماء)،والتي تحتوي على الكلورقد يكون عاملا مساعدا في زيادة الاصابة بالسمنة.
الاهداف: لتحديد العلاقة بين استخدام المواد الكيميائية المنزلية المحتوية على الكلور والتي تستعملها ربات البيوت والاصابة بالسمنة بين النساء المتزوجات ولاتي يقطن في المدينة المنوره.

تصميم الدراسة: دراسة مقطعية. وقد تم اختيار 1019 سيده من النساءالمتزوجات بطريقة عشوائية من الذين يترددون على الرعايه الصحيه في جامعة طيبة، و 20 مركزا للرعاية الصحية الأولية في المدينة المنوره. وقد تم اخذ جميع المقاييس الجسمية ، التاريخ الصحي الكامل.
النتائج: اوضحت النتائج وجود ارتباط معنوي كبير بين مؤشر كتلة الجسم للاناث المتزوجات وبين الاستخدام المتكررللمواد الكيميائية التي تحتوي على الكلور(P=0.002) .

الخلاصة: ان التعرض المتكرر للمواد الكيميائية والتي تسبب خلل في وظائف الغدد الصماء مثل المواد الكيميائية المحتوية على مشتقات الكلور قد يكون من احد العوامل المسببة للسمنة مع اهميه اجراء المزيد من الدراسات المستفيضه.