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Research Article

Sugar-Sweetened Beverage Consumption and Diabetes in Rural Panama

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Abstract

Background: Diabetes is one of the greatest global epidemics, with increased prevalence in low and middle-income nations. Identifying risk factors may aid the development of effective health interventions. The objective of this study is to explore the patterns of sugar-sweetened beverage (SSB) consumption based on gender and age, and assess the relationship between sugar intake and pre-diabetes and diabetes among adults in rural Panama.

Method: Data on SSB consumption (i.e., juice, soda, hot chocolate, tea, and coffee) were collected. Fasting and non-fasting blood glucose were measured in participants using Reli-On Prime glucometers. Blood sugar levels (BSL) were dichotomized as 'high 'or 'not high'. Descriptive statistics were performed to identify demographic characteristics, one-way ANOVAs were conducted to assess gender and age differences with SSB, and logistic regression was used to evaluate the association between beverage intake and BSL.

Result: Coffee and hot chocolate were the most consumed beverages among the fasting (mean [SD]=1.7[1.3] coffee, 2.1[1.4] hot chocolate) and non-fasting blood glucose groups (mean[SD]=1.9[1.5] coffee, 1.9[1.4]hot chocolate). Females in the fasting group showed significantly higher consumption of juice than males (1.6[1.2] vs. 1.0[0.8], $p<0.05$). Similarly, females in the non-fasting group consumed significantly more tea compared to males (1.3[1.0] vs. 1.1[0.9], $p<0.05$). Significant differences in SSB intake and age were found in the non-fasting blood glucose group; 21-30 year olds consumed more juice (1.5[1.0], $p< 0.01$) and hot chocolate (2.1[1.4], $p< 0.05$) per day than those who were older. In the fasting blood glucose group, 47.7% had high BSL, with an average SSB consumption of 4.7 [3.6] a day. There was no significant association between beverage consumption and BSL.

Conclusion: While sugar intake has been linked to pre-diabetes and diabetes, our findings suggest that SSB consumption was not a risk factor for diabetes. Further research that explores other modifiable and non-modifiable risk factors, within this population, is recommended.

Keywords: Diabetes; Epidemiology; Sugar-Sweetened Beverages

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Introduction

Diabetes, specifically type 2 diabetes mellitus (T2DM), has quickly become one of the largest worldwide epidemics of the 21st century. In 2007, global estimates reported more than 240 million individuals living with T2DM. It is predicted that by 2025, 380 million people will be affected, with 80% of those afflicted coming from nations of middle and low earnings [1]. Of concern is Latin America, which comprises about seven to eight percent of the world's population living with diabetes [2,3]. It is projected that by 2030, the number of diabetes cases within Latin America will be greater than any other area [2,3].

In Panama, where one-third of the population resides in rural settings, diabetes has become one of the greatest public health issues; ranking as the sixth common cause of mortality in the nation [4,5]. Within the last 30 years, Panama's economy and rate of urbanization have grown with people moving from indigenous and rural parts to urban areas. As a result of this, the migrant population has experienced lifestyle changes (e.g., reduced physical activity, unhealthy diet, smoking), which are well-known risk factors for cardio-metabolic disorders. There is a need to identify and address modifiable risk factors, and tailor health promotion efforts to prevent diabetes, which is a component of the non-communicable disease pandemic [1,6].

According to the literature, sugar-sweetened beverages (SSB) (e.g., fruit juices, carbonated sodas) are among the sugar sources that have been positively linked to weight gain, metabolic syndrome, cardiovascular disease, dental caries, and T2DM. As a result, the American Diabetes Association (ADA) suggested that individuals should not consume SSB in order to prevent development of diabetes [6-9]. Despite these findings and recommendations, some studies have reported contradictory information. For example, one study found that the intake of sucrose did not augment glycemia compared to other starch [10]. A similar finding was also reported among the diabetic population where the addition of sucrose to their diet did not have a negative influence on blood sugar control [10,11]. In another study, serum glycosylated albumin was less in the fructose-derived diet compared to that of starch [12]. Furthermore, repetitive juice (100% fruit) intake did not influence insulin resistance or glycemic control measures [13].

As more questions emerge regarding the relationship between increased sugar consumption and T2DM, it is important to note the lack of randomized controlled trials (RCT) supporting the original assumptions. This is essential when considering remote or rural populations, where there is limited literature that investigates the risk factors associated with diabetes. Of equal significance is the consideration of gender and age as factors that play a role in dietary habits and their influence on disease. It is suggested that gender and age, including behaviours that are influenced by culture, economics, geography, and lifestyle, should be explored when developing health policies [14]. In this paper, we investigate the role of gender and age in regard to SSB (i.e., juice, soda, coffee, tea, and hot chocolate) consumption patterns within Panama's underserved, rural populations. We also examine the relationship between SSB consumption and blood sugar levels (BSL) conducive to pre-diabetes and diabetes.

Materials and Methods

Participants and data collection

We gathered data on the daily consumption of SSB from people living in rural Panama via routine medical consults, which included social history information. Participants were shown a six-ounce paper cup and asked how many beverages (i.e., tea, coffee, hot chocolate, soda, juice) of approximately this size did they consume each day. Reli-On Prime glucometers (finger prick) were used to collect BSL from two samples of participants, the fasting blood glucose group and the non-fasting blood glucose group. Individuals over the age of 35 years,who have known diabetes, are under the age of 35 years with high clinical suspicion of diabetes, and/or anyone pregnant were tested for fasting blood glucose. Remaining participants were tested for random non-fasting blood glucose. According to the ADA, a BSL of 126mg/dl or more, for fasting blood glucose, suggests diabetes, 100mg/dl to 125mg/dl pre diabetes, and less than 100mg/dl normal [15]. Regarding non-fasting blood glucose, a BSL of 200mg/dl or more represents diabetes, 140mg/dl to 199mg/dl pre diabetes, and less than 140mg/dl normal. For the purpose of this study, we dichotomized BSL as 'high' or 'not high' for the fasting and non-fasting blood glucose groups. In the fasting blood glucose group, a BSL of 100mg/dl or greater was considered 'high' and less than 100mg/dl 'not high'. For the non-fasting blood glucose group, a BSL of 140mg/dl or more reflected 'high' and less than 140mg/dl 'not high'. Data was collected in mobile clinics.

Analyses

Descriptive statistics, in combination with independent sample t-test and chi-square, were performed to identify the demographic characteristics of the study participants. One-way ANOVAs were conducted to explore differences in SSB consumed based on gender, age, and BSL within the fasting and non-fasting blood glucose groups. Separate logistic regression models (odds ratio), with controls for age and family history of diabetes, were used to assess the association between consumption of SSB and BSL.

Results

Demographics

Of the 1,691 individuals, from rural Panama, who participated in the study, 239 were measured for fasting blood glucose and 1,452 were measured for non-fasting blood glucose (Table 1).

	Fasting Blood Glucose Group (N=239; N=179 males and N=52 females)	Non-fasting Blood Glucose Group (N=1,452; N=391 males and N=1,048 females)	P
	Mean (SD) or N (%)		
Age, years	40.0 (17.3)	43.0 (17.7)	.02[a]*
Number of daily SSB	4.7 (3.6)	4.8 (3.2)	.58[a]
Family history of diabetes	51 (21.3%)	258 (17.8%)	.12[b]
High BSL	114 (47.7%)	59 (4.1%)	<.0001[b]**

Table 1: Demographics of the fasting and non-fasting blood glucose groups.

[a]Calculated using independent samples t-test
[b]Calculated using chi-square test
*P<0.05; **P<0.0001

The gender reported among participants included 179 males and 52 females in the fasting blood glucose group while the non-fasting blood glucose group comprised of 391 males and 1,048 females. Participants who provided fasting blood glucose samples were significantly younger (mean [SD] = 40.0 [17.3] years) than those who provided non-fasting blood glucose measures (43.0 [17.7] years, $p < 0.05$). Consumption of SSB and family history of diabetes were comparable in both groups. High BSL were more prevalent in the fasting sample (N=114, 47.7%) compared to the non-fasting sample (N=59, 4.1%, $p < 0.0001$).

Patterns of SSB Consumption, including Differences in Gender, Age, and Glucose Levels

The most commonly consumed SSB among the fasting and non-fasting blood glucose groups were coffee and hot chocolate. The mean [SD] of coffee and hot chocolate consumed daily by participants in the fasting blood glucose group were 1.7 [1.3] and 2.1 [1.4], respectively. Among those in the non-fasting blood glucose group, coffee was 1.9 [1.5] and hot chocolate 1.9 [1.4]. Table 2 shows the distribution of the remaining SSB consumed per day. When comparing the daily consumption of SSB in the fasting blood glucose group with the non-fasting blood glucose group, no statistical significance was found.

	Non-fasting Blood Glucose Group	Fasting Blood Glucose Group	P
Coffee (n=1,452)	1.9 (1.5)	1.7 (1.3)	0.13
Juice (n=846)	1.3 (1.0)	1.5 (1.2)	0.27
Tea (n=896)	1.2 (1.0)	1.3 (1.3)	0.78
Hot Chocolate (n=1,102)	1.9 (1.4)	2.1 (1.4)	0.06
Soda (n=830)	1.2 (0.9)	1.3 (1.3)	0.29

Table 2: Mean (SD) distribution of SSB consumed per day in the fasting and non-fasting blood glucose groups.

In regard to gender differences with SSB consumed, females in both the fasting and non-fasting blood glucose groups consumed significantly more juice and tea than their male counterparts, respectively ($p < 0.05$) (Table 3).

	Non-fasting Blood Glucose Group			Fasting Blood Glucose Group	
	Males	Females	P	Males	Females
Coffee	2.0 (1.5)	1.8 (1.5)	0.07	1.8 (1.1)	1.7 (1.3)
Juice	1.2 (1.0)	1.4 (1.0)	0.08	1.0 (0.8)	1.6 (1.2)
Tea	1.1 (0.9)	1.3 (1.0)	0.01*	1.0 (0.8)	1.4 (1.5)
Hot Chocolate	1.9 (1.8)	1.9 (1.3)	0.91	2.3 (1.5)	2.1 (1.3)
Soda	1.2 (0.9)	1.2 (0.9)	0.85	1.3 (1.1)	1.4 (1.4)

Table 3: Gender differences and the mean (SD) distribution of SSB consumed per day among the fasting and non-fasting blood glucose groups.

*P<0.05
Non-fasting blood glucose group (coffee n=1,248, juice n=737, tea n=773, hot chocolate n= 948, soda n=718)
Fasting blood glucose group (coffee n=195, juice n=103, tea n=113, hot chocolate n=145, soda n=106)

Females in the fasting blood glucose group had a mean [SD] of 1.6 [1.2] of juice per day compared to males 1.0 [0.8]. With respect to gender differences and tea consumption among the non-fasting blood glucose group, females were 1.3 [1.0] and males were 1.1 [0.9].

Further assessment of SSB consumption patterns showed statistically significant differences among the age categories of those in the non-fasting blood glucose group (Table 4).

Participants ages 21 to 30 years consumed on average more juice (1.5 [1.0], $p< 0.01$) and hot chocolate (2.1 [1.4], $p< 0.05$) per day than their older and younger counterparts. No other statistical significance was reported in the non-fasting and fasting blood glucose groups.

In Table 5, we explored the differences in SSB consumption and BSL (high or not high) for the fasting and non-fasting blood glucose groups.

Analysis shows that there are statistically significant differences in the BSL of participants with fasting blood glucose who consumed juice or hot chocolate regularly ($p< 0.05$). Among the fasting blood glucose group with high BSL, 1.2 [0.8] drinks of juice were consumed daily compared to 1.7 [1.4] of those with not high BSL. Regarding hot chocolate intake, 1.9 [1.4] were reported by participants with high BSL and 2.4 [1.3] by those with not high BSL. Therefore, those in the fasting blood glucose group who consumed more juice or hot chocolate had lower BSL than their counterparts. In regard to the remaining SSB, no other statistical significance was found in either group.

Associations between SSB and BSL

Table 6 shows the unadjusted and adjusted associations between daily SSB consumption and BSL in the fasting and non-fasting blood glucose groups. No statistically significant associations were found between the consumption of SSB and BSL in either group.

Non-fasting Blood Glucose Group	Under 20	21-30	31-40	41-50	51-60	61+	P
Coffee	1.7 (1.6) (n=140)	1.8 (1.2) (n=193)	2.0 (1.9) (n=263)	2.0 (1.5) (n=260)	2.0 (1.5) (n=187)	1.8 (1.4) (n=217)	.09
Juice	1.4 (1.1) (n=93)	1.5 (1.0) (n=124)	1.3 (1.0) (n=150)	1.0 (0.8) (n=132)	1.2 (0.9) (n=115)	1.3 (1.0) (n=129)	<.01**
Tea	0.9 (1.1) (n=74)	1.4 (1.1) (n=128)	1.5 (1.0) (n=166)	1.2 (1.0) (n=153)	1.2 (0.8) (n=114)	1.3 (1.0) (n=147)	.08
Chocolate	1.6 (1.0) (n=105)	2.1 (1.4) (n=141)	2.1 (1.3) (n=207)	2.0 (1.6) (n=202)	1.9 (1.6) (n=145)	1.6 (1.5) (n=157)	.02*
Soda	1.2(1.0) (n=89)	1.2 (1.1) (n=98)	1.3 (0.9) (n=148)	1.2 (0.9) (n=147)	1.2 (0.6) (n=112)	1.2 (0.8) (n=130)	.87
Fasting Blood Glucose Group							
Coffee	1.3 (1.0) (n=26)	1.8 (1.3) (n=43)	2.0 (1.7) (n=41)	1.7 (1.1) (n=36)	2.0 (1.1) (n=22)	1.6 (0.9) (n=28)	.30
Juice	1.5 (0.8) (n=11)	1.6 (1.6) (n=25)	1.8 (1.3) (n=27)	1.2 (0.7) (n=15)	1.1 (0.7) (n=11)	1.0 (0.6) (n=14)	.30
Tea	1.2 (1.2) (n=16)	1.1 (1.3) (n=15)	1.4 (1.9) (n=29)	1.0 (0.7) (n=27)	1.6 (1.3) (n=14)	1.3 (0.7) (n=13)	.72
Chocolate	2.2 (1.0) (n=16)	2.2 (1.2) (n=30)	2.6 (1.9) (n=34)	1.6 (0.9) (n=31)	2.2 (1.0) (n=12)	2.2 (1.4) (n=22)	.11
Soda	1.8 (1.7) (n=10)	1.2 (1.0) (n=19)	1.6 (2.0) (n=25)	1.0 (0.7) (n=24)	0.7 (0.4) (n=13)	1.6 (1.3) (n=15)	.18

Table 4: Gender differences and the mean (SD) distribution of SSB consumed per day among the fasting and non-fasting blood glucose groups.

Note: P-values derived from one-way ANOVA
*P<0.05; **P<0.01

	Non-fasting Blood Glucose Group			Fasting Blood Glucose Group		
	Not High BSL	High BSL	P	Not High BSL	High BSL	P
Coffee	1.9 (1.5)	1.7 (1.3)	0.34	1.7 (1.0)	1.8 (1.0)	0.86
Juice	1.3 (1.0)	1.3 (0.8)	0.87	1.7 (1.4)	1.2 (0.8)	0.04*
Tea	1.2 (1.0)	1.4 (0.9)	0.18	1.2 (1.0)	1.3 (1.5)	0.76
Chocolate	1.9 (1.8)	2.1 (1.6)	0.48	2.4 (1.3)	1.9 (1.4)	0.03*
Soda	1.2 (0.9)	1.2 (0.9)	0.81	1.6 (1.2)	1.2 (1.4)	0.13

Table 5: Differences in BSL and the mean (SD) distribution of SSB consumed per day in the fasting and non-fasting blood glucose groups.

*P<0.05
Non-fasting blood glucose group (coffee n=1,260, juice n=743, tea n=782, hot chocolate n= 957, soda n=724)
Fasting blood glucose group (coffee n=196, juice n=103, tea n=114, hot chocolate n=145, soda n=106)

	UOR (95%CI)	P	AOR (95%CI)	P
Fasting Blood Glucose Group (n=239)	1.0 (0.9-1.1)	.62	1.0 (1.0-1.1)	.47
Non-Fasting Blood Glucose Group (n=1,452)	1.0 (0.9-1.1)	.44	1.0 (0.9-1.1)	.72

Table 6: Unadjusted odds ratios (UOR) and adjusted odds ratios (AOR) for the association between SSB consumed per day and BSL in the fasting and non-fasting blood glucose groups.

Note: AOR is adjusted for age and family history of diabetes

Discussion

The results of the present study suggest that the population of rural Panama consume on average more SSB daily compared to those in the Caribbean who drink 3.0 servings of SSB per day [8]. Our findings show that among the fasting and non-fasting blood glucose groups, the most commonly consumed SSBs were coffee and hot chocolate. A possible explanation for the increased consumption of SSB in this population may be the replacement of plain drinking water, which is noted to be contaminated and unhealthy for individuals living in the remote rural areas of Panama [16]. A look at SSB consumption patterns based on gender also show that female participants consumed significantly more juice (fasting blood glucose group) or tea (non-fasting blood glucose group) than their male counterparts. It has been reported that, globally, women, in particular those between 20 to 39 years old, drink more juice compared to men, which supports our findings. The juice consumed by women in our study was on average 1.6 servings/day, which is ten-fold higher than the global average of juice consumed by adults (0.16 servings/day).With respect to SSB consumption and age, we found that participants of the non-fasting blood glucose group who were 21 to 30 years old preferred and consumed significantly more juice and hot chocolate compared to any other age group.

Other differences we found pertain tojuice and hot chocolate consumption and fasting BSL. Among the participants of the fasting blood glucose group, those who consumed significantly more juice or hot chocolate had lower or normal BSL. These results may suggest a potential "protective effect" of juice and hot chocolate in regard to the hepatic glucose production, which is responsible for fasting blood glucose levels. Several reports indicate the negative impact of juices with respect to metabolic changes and the increased risk of diabetes and/or weight gain [7,8]. However, literature shows that juices, made of 100% fruit, can offer vitamins (e.g., A and C), minerals (e.g., Mg, Ca^{2+}), flavonoids, carotenoids, and bioactive ingredients.When drunk in moderation, juices may serve as a significant source of nutrients[8].Another study suggests that the risk for diabetes may not be related to juices (e.g., grapefruit and orange)that are taken with meals [17]. Regarding hot chocolate, there are reports of health-promoting properties found in cocoa and chocolate products, such as minerals (i.e., Mg) and antioxidants (i.e., procyanidins, catechin, epicatechin), which may explain their cardio-metabolic benefits [18,19]. For example, Kuna Indians, who live on the offshore islands of Panama, consume cocoa (over five cups)regularly and reportedly have a lower risk of mortality from diabetes compared to those living on the mainland. In contrast to other SSB, the smell or taste of chocolate can have an appetite-suppressive role, which may describe the beneficial effect on the BSL. Although literature supports the notion that SSB consumption increases the risk of metabolic syndrome and T2DM, our study showed no significant relationship between SSB consumption and BSL conducive to pre-diabetes and diabetes. This finding suggests that the high prevalence of juice and hot chocolate consumed by our study participants may have beneficial metabolic effects.

With respect to SSB consumption and BSL, we did not see any significant association in either the fasting or non-fasting blood glucose groups. This outcome supports previous studies which found that drinking tea or coffee did not influence the mean glycaemic index, and an increase intake of coffee was related to a reduced risk for diabetes in adults [20,21]. Additionally, SSB, in particular sodas, are considered to have amoderate glycaemic index, however, if they are drunk in greater amounts, they can increase the glycaemic load. Among our study participants, soda intake was the lowest for both males and females in the fasting and non-fasting blood glucose groups. These findings confirm the notion that consuming certain SSB may not negatively influence the BSL. Nonetheless, our data warrants further exploration as to whether or not SSB consumption is a risk factor for T2DM in this specific population.

Our study presents several strengths. We focused on a marginalized population of rural Panama where there is limited information regarding SSB consumption and its implications, particularly T2DM and associated risk factors. Secondly, we reported patterns of SSB consumption based on gender and age differences and explored the association between SSB intake and the risk of pre-diabetes and diabetes. Furthermore, we note that not all SSB are the same and some of them (i.e., juice and hot chocolate) may have health benefits in regard to diabetes and its co-morbidities. Lastly, our study supports more recent literature, which shows that the association between SSB (e.g., fruit juice) and metabolic changes is more complex than originally thought and additional research is required. Despite these strengths, our study did encounter some limitations. First, due to the sample selection criteria, we had an unequal distribution of fasting and non-fasting blood glucose groups, particularly with respect to gender and age; a majority of the participants were identified as non-fasting. In addition, because the study was performed with a marginalized population in rural Panama, generalize ability may be limited. Second, our study entailed one-on-one interviews, which may be prone to recall bias; however, we do not expect to see more than that reported in the general population. Third, we did not explore other modifiable and non-modifiable risk factors that may play a confounding role in the development of pre-diabetes and diabetes.

For future research, a 24-hour dietary recall, food frequency questionnaire, and/or weekly food consumption logs may be beneficial and provide more information. Identifying modifiable and non-modifiable risk factors associated with diabetes can also aid in the design and implementation of tailored healthcare interventions. For example, Pima Indians, who have the greatest prevalence of diabetes documented worldwide, are also known to have a genetic predisposition for T2DM. Analysis suggests that certain genes may play a significant role regarding the susceptibility to develop T2DM, particularly in the presence of unhealthy lifestyle changes [22]. While there is much research to be done, it is important to note that certain populations are more at risk for diabetes than other populations and diabetic risk factors are not one-size-fits-all. Though this study has focused on one homogenous ethnicity in one Panamanian region, this population does share some similarities with other populations throughout Central and South America, including other continents. Therefore, the results of future studies in Panama have implications for re-prioritization of parallel studies or interventions across the globe.

Conclusion

Our study showed that the population of rural Panama has a high consumption of SSB, which may have a limited role on the high prevalence of diabetes reported in this population. Overall, this study has shown that the current understanding of diabetes risk factors may not hold strong in every population around the world. More research, through RCT, is needed in order to better understand the role of diet and other modifiable risk factors for developing metabolic syndrome and diabetes. Furthermore, the protective role and health benefits of certain SSB, including the quantity and timing of their consumption, should be explored. It is imperative that healthcare interventions and resources are being used as efficiently as possible, especially in low-resource settings. Identification of essential diabetic risk factors in selected high-risk populations can help to prioritize individualized healthcare interventions to have the maximum possible impact and benefit. Additionally, since incentives are known to influence behavioural changes, it is also important to take this into consideration when designing health interventions.

Conflicts of interest

No funding was used to prepare this manuscript and the authors disclose no conflicts of interest.

References

1. Hu FB, Malik VS (2010) Sugar-sweetened beverages and risk of obesity and type 2 diabetes: Epidemiologic evidence. Physiol Behav 100:47-54.
2. Posso AJM, Meza RAB, Morales EAM, Jaen Y, Ortega AC, et al. (2015) Diabetes in Panama: Epidemiology, risk factors, and clinical management. Ann Glob Health 81: 754-764.
3. Aschner P, Aguilar-Salinas C, Aguirre L, Franco L, Gagliardino JJ, et al. (2014) Diabetes in South and Central America: an update. Diabetes Res Clin Pract 103: 238-243.
4. Motta JA, Ortega-Paz LG, Gordon CA, Gomez B, Castillo E, et al. (2013) Diabetes mortality in Panama and related biological and socioeconomic risk factors. Rev Panam Salud Publica 34: 114-120.
5. Trading Economics.
6. Cheema A, Adeloye D, Sidhu S, Sridhar D, Yee Chan K (2014) Urbanization and prevalence of type 2 diabetes in Southern Asia: A systematic analysis.J Glob Health 4.
7. Popkin BM, Hawkes C (2016) The sweetening of the global diet, particularly beverages: Patterns, trends and policy responses for diabetes prevention. Lancet Diabetes Endocrinol 4: 174-186.
8. Singh GM, Micha R, Khatibzadeh S, Shi P, Lim S, et al. (2015) Global, regional, and national consumption of sugar-sweetened beverages, fruit juices, and milk: A systematic assessment of beverage intake in 187 countries. PLoS One 10.
9. American Diabetes Association.
10. Franz MJ, Bantle JP, Beebe CA, Brunzell JD, Chiasson JL, et al. (2002) Evidence-based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. Diabetes Care 25:148-198.
11. Nadeau J, Koski KG, Strychar I, Yale JF (2001) Teaching subjects with type 2 diabetes how to incorporate sugar choices into their daily meal plan promotes dietary compliance and does not deteriorate metabolic profile. Diabetes Care 24: 222–227.
12. Bantle JP, Swanson JE, Thomas W, Laine DC (1992) Metabolic effects of dietary fructose in diabetic subjects. Diabetes Care 15:1468-1476.
13. Murphy MM, Barrett EC, Bresnahan KA, Barraj LM (2017) 100 % Fruit juice and measures of glucose control and insulin sensitivity: a systematic review and meta-analysis of randomised controlled trials. J Nutr Sci 6.
14. Reyes CM, Cornelis MC (2018) Caffeine in the diet: country-level consumption and guidelines. Nutrients 10: 1772.
15. American Diabetes Association.
16. Larsen MC (2019) Water supply and water quality challenges in Panama. In S Ajuha (ed.). Advances in Water Purification Techniques. Elsevier, Amsterdam, Netherlands 41-46.
17. Palmer JR, Boggs DA, Krishnan S, Hu FB, Singer M, et al. (2008) Sugar-sweetened beverages and incidence of type 2 diabetes mellitus in African American women. Arch Intern Med. Jul 28; 168(14): 1487–1492.
18. Katz DL, Doughty K, Ali A (2011) Cocoa and chocolate in human health and disease. Antioxid Redox Signal 15: 2779-2811.
19. Hollenberg NK, Fisher NDL, McCullough ML (2009) Flavanols, the Kuna, cocoa consumption, and nitric oxide.J Am Soc Hypertens 3.
20. Aldughpassi A, Wolever TMS (2008) Effect of coffee and tea on the glycaemic index of foods: No effect on mean but reduced variability. Br J Nutr 101(9): 1282-1285.
21. Paynter NP, Yeh HC, Voutilainen S, Schmidt MI, Heiss G, et al. (2006) Coffee and sweetened beverage consumption and the risk of type 2 diabetes mellitus:the atherosclerosis risk in communities study. Am J Epidemiol 164:1075-1084.
22. Narayan KMV (1996) Diabetes mellitus in Native Americans: the problem and its implications. In GD Sandefur, RR Rindfuss, B Cohen (eds.). Changing Numbers, Changing Needs: American Indian Demography and Public Health. National Academies Press, Washington D.C., United States.