Diabetes and impaired fasting glucose in rural and urban populations in Futa Jallon (Guinea): prevalence and associated risk factors

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Abstract

\textbf{Aim.} – The authors present the results of the first survey conducted among the population of the Futa Jallon province in Guinea on the prevalence of diabetes mellitus (DM) and impaired fasting glucose (IFG) and associated risk factors for diabetes.

\textbf{Method.} – A random sample of the study population selected by cluster house sampling method included 1537 Guineans (807 women and 730 men) aged 35 years and above in urban (Labé) and rural (Fellö Koundoua-Tougué) areas. Participants were examined and administered a capillary whole blood glycemia test.

\textbf{Results.} – The mean age of subjects was 49.4 years. Participation rate was 77%. Overall crude diabetes and IFG prevalence were 6.1% and 13.4%, respectively. The age-adjusted prevalence of diabetes using the standardized age distribution of Segi was 6.7% (95% CI: 5.5–7.9%). Subjects in the urban area had twice as much DM as in the rural area (OR 2.0, 95% CI: 1.3–3.2). Out of the 94 subjects with DM, 66 had no prior history of disease. Urban location, age, waist to hip ratio, excess waist circumference, hypertension, raised systolic and diastolic blood pressures were significantly positively associated with DM. In multivariate analysis, only age ($P = 0.002$) and waist circumference ($P < 0.05$) remained independently associated with DM.

\textbf{Conclusion.} – The prevalence of DM was higher than expected in urban and rural areas. The data support the conclusion that prevalence of DM is expected to increase with the aging of the population. The factors associated with diabetes are potentially modifiable. Therefore, primary prevention through lifestyle modifications may play a critical role in the control of DM.

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Résumé

Diabète et hyperglycémie modérée à jeun en milieu rural et urbain au Fouta Djallon (Guinée) : prévalence et facteurs de risque.

\textbf{Objectifs.} – Les auteurs présentent les résultats de la première enquête de population menée au Fouta Djallon en Guinée sur la prévalence du diabète sucré, de l’hyperglycémie modérée à jeun (HJM), et les facteurs de risque associés au diabète.

\textbf{Méthodes.} – Un échantillon aléatoire de 1537 guinéens (807 femmes et 730 hommes) âgés de 35 ans et plus a été sélectionné et examiné à partir d’un tirage au sort des habitats, en milieu rural (Fellö Koundoua–Tougué) et urbain (Labé). Les participants ont été examinés et une glycémie capillaire réalisée.

\textbf{Résultats.} – L’âge moyen des sujets inclus dans l’étude était de 49,4 ans. Le taux de participation était de 77 %. Les prévalences globales du diabète et de l’HJM étaient respectivement de 6,1 et 13,4 %. La prévalence du diabète standardisée pour l’âge de la population mondiale était de 6,7 % (IC 95 % : 5,5–7,9 %). La fréquence du diabète était deux fois plus importante chez les sujets vivant en milieu urbain comparativement à...
en milieu rural (Odds ratio : 2.0 ; IC 95 % : 1.3–3.2). Parmi les 94 sujets diabétiques, 66 n’étaient pas connus auparavant. L’habitat en milieu urbain, l’âge, le rapport du tour de taille (TT) sur le tour de hanche, l’excès de TT, l’hypertension, ainsi que l’augmentation de la pression artérielle (PAS) systolique et celle de la pression artérielle diastolique (PAD) étaient positivement et significativement associés au diabète. En analyse multivariée, seuls l’âge (P = 0.002) et l’excès de TT (P < 0.05) demeuraient indépendamment associés au diabète.

Conclusion. — La prévalence du diabète était plus importante qu’attendue en zone urbaine et en zone rurale. Les résultats suggèrent une progression de la prévalence du diabète avec le vieillissement de la population. Les facteurs de risque associés au diabète sont potentiellement modifiables. De ce fait, la prévention primaire par les changements du style de vie peut avoir un rôle majeur à jouer dans le contrôle du diabète.

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Keywords: Diabetes mellitus; Impaired fasting glucose; Rural; Urban; Associated factors

Mots clés : Diabète sucré ; Hyperglycémie modérée à jeun ; Rural ; Urbain ; Facteur de risque

1. Introduction

Diabetes mellitus (DM) is a major emerging health problem in Africa where management is complicated by poor socioeconomic conditions [1]. The prevalence of type 2 diabetes is increasing worldwide and data on true frequency of the disease are essential for planning health care services in all countries [2]. From reported studies, the prevalence of DM varies considerably between rural and urban areas in Africa [3,4]. Recent studies in urban populations suggest that the disease may now be more common in sub-Saharan Africa than previously thought [5,6].

No epidemiological information has been available from Guinea about DM, but based on clinical observations an increasing prevalence is thought to exist [7], at least for Conakry Teaching Hospital. Furthermore, data collected in Nigeria [8] and Mali [9] suggested that a Fulani ethnic group would be exposed to greater risk of DM.

The aim of this study was to give an estimation of the prevalence of DM and impaired fasting glucose (IFG) in rural and urban areas of Futa Jallon in Guinea and to investigate the factors which are associated with DM.

2. Methods

2.1. Target population and sampling

Guinea is a West African country with a tropical climate. According to the most recent Guinean census, the population is made up of 7156,406 inhabitants with 49% men and 51% women [10]. The rural population was estimated at 70% of subjects and 60% of Guineans are under 20 years of age. Futa Jallon province, in the north of the country, has a population of 1639,617 inhabitants and the Fulani represent the predominant ethnic group. Labé, the largest city in Futa Jallon, was selected for the urban survey while Fellô-Koundoua (in the prefecture of Tougoué) was chosen for rural sampling. Labé is the fourth largest city in Guinea, situated 431 km north-east of Conakry with a population of 79,347. Fellô-Koundoua is 193 km further north, between Labé and Tougoué, and has a population of 5932. Choice of this latter site was based on criteria defining its rural situation (isolation, difficulty of access by road, low levels of infrastructure, traditional lifestyle and diet) contrasting with that of the urban zone of Labé.

Guinean men and women of African origin aged 35 years and above were studied. A sample size of 384 was determined, based on an estimate of DM prevalence of 50%, to obtain an absolute precision of 5% for the 95% confidence interval (95% CI). This sample size was multiplied by the maximum design effect for clustering of two to give a sample of 768. To allow for a non-response rate of 30%, a final sample size of 1000 per community was employed. We randomly selected houses from the list of the last Guinean census [10]. All residents of these houses aged 35 years and over were invited to take part in the study. Non-participation linked to absence was recorded after two visits to the household.

2.2. Survey personnel

The study team was composed of epidemiologists, nurses and physicians. To standardize survey measurements and procedures, the survey team was trained in the use of a specially prepared manual conforming to recommended non-communicable disease survey protocols [11]. All field workers were trained and certified to administer the questionnaire, to take anthropometric and blood pressure measurements and to draw blood. The study was performed between February 1 and March 15 2003, during a period without intensive agricultural activity.

2.3. Survey methods

After informed consent was obtained, subjects were taken through a questionnaire administered in one session and which recorded name, age, sex, ethnic group, medical history, obstetric history and family history of DM. The questionnaire was orally translated into Fulani for persons who did not understand French. Height was measured with a measuring tape to the nearest cm. Weight was measured in light clothing and without shoes, using a floor digital scale to the nearest 0.1 kg. Waist and hip circumference were measured using a flexible tape measure. After at least 10 min rest, blood pressure was measured on the right arm of seated subjects on two occasions, at an interval of 1 min, using an appropriate size sphygmomanometer. Subjects were examined during the morning.
after fasting since the previous evening meal. Capillary whole blood was obtained from a finger puncture and was immediately analyzed using a Hemocue blood glucose analyzer (Hemocue® AB, Box 1204, 26223 Angelholm, Sweden).

2.4. Criteria for diagnosis

The participants were divided into three categories according to international standards [12,13]:

1) those who were not diabetic, where capillary whole blood glucose was less than 5.5 mmol/l;
2) those with IFG, where capillary whole blood glucose was between 5.5 and 6.1 mmol/l;
3) those with DM, who had either been previously diagnosed DM or had capillary whole blood glucose value greater than or equal to 6.1 mmol/l and had symptoms of diabetes.

Prevalence rates were estimated considering known cases and newly-found ones together. Patients were considered to be hypertensive if they were being treated for known hypertension, or if their mean diastolic blood pressure was greater than or equal to 90 mmHg and their systolic blood pressure was greater than or equal to 140 mmHg. Central obesity has been defined as a waist/hip ratio (WHR) of 0.85 or more for women and of 0.95 or more for men. Individuals with BMI of 30 kg/m² and greater are considered obese [14]. The cutoffs used for selected variables were defined according to the latest IDF recommendations: waist circumference according to gender (≥94 cm for male and ≥80 cm for female), raised systolic (≥130 mmHg) and diastolic (≥85 mmHg) blood pressures [15].

2.5. Statistical procedures

Data are expressed as mean ± standard deviation (S.D.). The Student’s unpaired, two-sided t-test was used to compare means between the two groups. The Chi-square test was used in the comparison of proportions. To identify factors associated with DM among various groups, calculations were based on means, 95% CI, and proportions. The strength of association between the dependent variables was assessed using odds ratio (OR) in logistic regression analyses. The bi-variate association between diabetes status (non-diabetic or diabetic) and each of the independent variables was examined. In a final, multiple logistic regression analysis, using the backward stepwise conditional method, the co-variables included were those that were both more sensitive and had been shown to have a statistically significant association with the dependent variable (non-diabetic or diabetic) in bi-variate analysis. Prevalence estimates were age-standardized to the Guinean population by the direct method, using a population from 35 years and above according to the last Guinean census [10]. In addition, the prevalence estimate was age-standardized to the African and World populations [16].

Statistical Analysis Software (SAS Inc. 9.1, Cary, NC, USA) was used for analysis. The level of statistical significance was set at $P < 0.05$.

2.6. Ethics

The study was approved by the Ethical and Protocol Review Committee of the Guinean Ministry of Health and complied with the Helsinki Declaration of 1975 (revised in 1983 and 1989) on human experimentation. Informed consent was obtained from all participants. Confidentiality was maintained in accordance with standard medical practice.

3. Results

3.1. Characteristics of the participants

Out of a total of 2000 subjects selected, 1537 subjects participated in the study, giving a response rate of 77%. The response rate was 65% and 88% for the rural and urban population, respectively. The reasons for this limited response rate were not formally identified by the questionnaire. The reasons included absence from home at the time of the study, and refusal to participate. The study population was predominantly Fulani (93.2%) and Muslim (99.9%). Sixty two percent of subjects were over 40 years old.

Table 1 shows the means ± S.D. of selected variables for men and women according to the location (rural or urban). The mean age of subjects was $49.4 ± 12.9$ (35–85) years. There were more women (807; 52.5%) than men (730; 47.5). In the sample studied, urban subjects ($52.2 ± 13.3$) were older than rural ones ($45.6 ± 11.3$) ($P < 0.001$). Men were older than women ($47.66 ± 51.35$ years; $P < 0.001$) and had lower BMI ($21.7$ versus $23.5$ kg/m²; $P < 0.001$). A total of 77 men and 222 women were obese, giving a total prevalence in the population of 19.5%. In both locations, subjects differed according to gender. Men and women in the urban area were older, had larger waist circumference, WHR, systolic and diastolic blood pressure ($P < 0.0001$) than those in the rural area. Women in the urban area had higher BMI ($P < 0.0001$) and fasting plasma glucose concentrations than those in the rural area ($P < 0.02$) while no difference was seen in men. Overall obesity prevalence was 5.1% of all subjects we studied (0.6% in the rural area and 8.4% in the urban area; $P < 0.001$).

3.2. Prevalence of diabetes, IFG, and associated factors

The numbers of subjects with IFG, screened as DM and treated for DM by the survey according to location (rural and urban) are shown in Table 2. DM affects 6.1% (95% CI: 4.9–7.3) of the population aged 35 years and above (4.0% in rural and 7.7% in urban; $P < 0.01$) while IFG affects 13.4% (95% CI: 11.7–15.1) of the population aged 35 years and above (17.7% in rural and 10.3% in urban areas). In the
urban area 59% (40 of 68) of diabetic subjects were unknown before the survey, compared with 100% in the rural area. The age-standardized prevalence of DM according to Guinean census was 6.5% (95% CI: 5.3–7.7), while age-standardized prevalence according to African and world population was, respectively, 5.5% (95% CI: 4.4–6.6) and 6.7% (95% CI: 5.5–7.9). The age-standardized prevalence of DM was not different in the urban sample when compared with the rural one (P = 0.3).

The prevalence of hypertension observed in this study was 14.9% in the rural population and 43.6% in the urban population (P < 0.0001). A total of 37 (2.5%) subjects reported a family history of DM. Macrosomia was reported among 4.3% of women.

### 3.3. Associated factors

Comparisons of selected factors according to the presence or absence of DM are shown in Table 3. Prevalence of DM in the urban area was two times higher than in the rural area (OR: 2.0, 95% CI: 1.3–3.2). In bi-variate analysis the subjects with DM were from an urban location (P < 0.01), and of greater age (P < 0.0001), WHR (P < 0.05), excess of waist circumference (P < 0.01), hypertension (P < 0.01), raised systolic (P < 0.0001) and diastolic (P < 0.01) blood pressures. The prevalence of DM was not different in men compared to women (P = 0.94). Obesity was seen in 4.9% of the non-diabetic subjects and in 8.5% of the diabetic subjects (P = 0.12). Obesity prevalence did not differ in the two groups, but the mean BMI was significantly different (P < 0.01) when non-diabetic and diabetic subjects were compared. Prevalence of hypertension in diabetic subjects was two times higher than in non-diabetic subjects (OR: 1.8, 95% CI: 1.2–2.5).

Co-variables included in the model in logistic multivariate regression were: location (rural versus urban), age group, excess of waist circumference according to gender (≥ 85 mmHg). Out of these, only age group (P = 0.002) and excess of waist circumference (P < 0.05) were co-variables independently associated to DM (Table 3).

### 4. Discussion

This study provides the first representative population based estimates of the prevalence of DM and IFG in Guinea. These data provide baseline figures for the planning of health care policy and establishment of medical priorities in this part of Guinea, where the majority of the population is Fulani. The Fulani ethnic group which consisted of nomadic shepherds in
the past now lives in fixed settlements. Our data confirms those collected in Nigeria [8] and Mali [9] suggesting that the Fulani have a high prevalence of diabetes. Adjustment of the crude prevalence rate to that of Guinean African adults or the world standard population did not provide evidence of great differences in rates of DM. Thus, these results are consistent with the fact that DM is more frequent than was previously thought.

Table 3
Comparison of selected factors according to the presence or absence of diabetes

<table>
<thead>
<tr>
<th>Factors</th>
<th>Number of subjects (%)</th>
<th>Percent of diabetes</th>
<th>OR (95% CI)</th>
<th>P value bi-variate analysis</th>
<th>P value multivariate analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Site</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>651 (42)</td>
<td>4.0</td>
<td>1.00 (Reference)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>886 (58)</td>
<td>7.7</td>
<td>2.0 (1.25–3.18)</td>
<td>0.003</td>
<td>0.42</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35–44</td>
<td>673 (43.8)</td>
<td>3.1</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45–54</td>
<td>339 (22.1)</td>
<td>6.5</td>
<td>2.15 (1.17–3.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55–64</td>
<td>282 (18.3)</td>
<td>7.8</td>
<td>2.63 (1.42–4.86)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74</td>
<td>173 (11.3)</td>
<td>11.6</td>
<td>4.05 (2.15–7.68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥75</td>
<td>70 (4.5)</td>
<td>12.9</td>
<td>4.58 (2.01–10.44)</td>
<td>&lt;0.0001</td>
<td>0.0002</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>730 (47.5)</td>
<td>6.2</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>807 (52.5)</td>
<td>6.1</td>
<td>0.98 (0.65–1.49)</td>
<td>0.94</td>
<td>–</td>
</tr>
<tr>
<td><strong>Obesity</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>No (body mass index &lt;30 kg/m²)</td>
<td>1459 (95)</td>
<td>4.9</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (body mass index ≥30 kg/m²)</td>
<td>78 (5)</td>
<td>8.5</td>
<td>1.82 (0.85–3.91)</td>
<td>0.12</td>
<td>–</td>
</tr>
<tr>
<td><strong>Central obesity</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>WHR &lt;0.85 (women) or &lt;0.95 (men)</td>
<td>542 (35)</td>
<td>4.4</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHR ≥0.85 (women) or ≥0.95 (men)</td>
<td>995 (65)</td>
<td>7.0</td>
<td>1.63 (1.01–2.63)</td>
<td>0.04</td>
<td>–</td>
</tr>
<tr>
<td><strong>Waist circumference (cm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist &lt;80 (women) or &lt;94 (men)</td>
<td>1205 (78)</td>
<td>5.6</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist ≥80 (women) or ≥94 (men)</td>
<td>332 (22)</td>
<td>9.6</td>
<td>1.96 (1.26–3.07)</td>
<td>0.003</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1054 (69)</td>
<td>4.9</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (blood pressure ≥140 and ≥90 mmHg)</td>
<td>483 (31)</td>
<td>8.7</td>
<td>1.84 (1.20–2.80)</td>
<td>0.004</td>
<td>–</td>
</tr>
<tr>
<td><strong>Raised systolic blood pressure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic &lt;130 mmHg</td>
<td>902 (59)</td>
<td>4.1</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic ≥130 mmHg</td>
<td>635 (41)</td>
<td>9.0</td>
<td>2.30 (1.50–3.53)</td>
<td>&lt;0.0001</td>
<td>0.09</td>
</tr>
<tr>
<td><strong>Raised diastolic blood pressure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic &lt;85 mmHg</td>
<td>1145 (74.5)</td>
<td>5.2</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diastolic ≥85 mmHg</td>
<td>392 (25.5)</td>
<td>8.9</td>
<td>1.80 (1.17–2.79)</td>
<td>0.007</td>
<td>0.72</td>
</tr>
</tbody>
</table>

a 95% CI, 95% confidence interval.

b Logistic regression: associated risk factors were selected stepwise in model taking diabetes as a dependent variable. Co-variables included in the model were: location (rural versus urban), age group, excess of waist according to gender (≥80 for male or ≥94 for female), raised systolic blood pressure (≥130 mmHg) and raised diastolic blood pressure (≥85 mmHg).

The association between DM and age supports the conclusion that the prevalence of DM is expected to increase with the aging of the population. Urbanization has been strongly associated with DM prevalence in many developing countries. The prevalence of DM in African communities is increasing with lifestyle changes associated with rapid urbanization and westemization: dietary changes, reduction in physical activity, and increasing obesity [17]. The rural community is engaged in more physical occupations such as farming, walking and cooking for women and is probably more active than the unemployed and professional urban population. In the cities particularly, women have less physical activity because they walk less, enjoy more support for cooking and nursing, and they do not normally work outside the family.
Less than half of the DM cases we report had been diagnosed in the urban area previous to the survey, and none in the rural area. This relatively high level of undiagnosed cases of DM in Guinea reflects poor public awareness and lack of medical services. In many parts of the country, particularly in rural areas, traditional healers are the first line contact for patients. In Guinea, diabetes teams exist only in two cities (Conakry the capital city and Labé). Therefore, integration of diabetes care into primary care may be helpful. Management of chronic disorders such as DM in rural African communities needs to be decentralized. These hurdles in accessing support are compounded by the paucity of trained healthcare staff [22].

The prevalence of hypertension observed in this study was 14.9% in the rural population and 43.6% in the urban population, which was consistent with recently published estimates from this country [23], indicating that the problem of high blood pressure is common in sub-Saharan African communities [24].

Factors associated with DM in bi-variate analysis in this study were location (rural versus urban), age group, central obesity, excess of waist circumference, hypertension, raised systolic blood pressure and diastolic blood pressure. The mean BMI was significantly different when non-diabetic and diabetic subjects were compared, but no difference was seen with obesity. Only 5% of the population we studied was obese (4.9% of the non-diabetic subjects and 8.5% of the diabetic subjects). The absence of reference data on obesity in Guinea does not allow judging its level in this region. In general, the cut-off points used to define obesity and the metabolic syndrome as identifier risks of type 2 diabetes and cardiovascular disease in sub-Saharan Africans remain to be validated. Indeed, in a final logistic multivariate regression, only age group and waist circumference were co-variables that were independently associated with DM. It is well known that obesity, especially visceral abdominal fat, is an established risk factor of developing type 2 DM and IFG [25]. In a group of black hypertensive women, measures of central obesity were more strongly associated with components of the metabolic syndrome than BMI [26].

The frequency of DM in Guineans, compounded by hypertension, presents a complex picture for health workers and policy makers. Increasing emphasis needs to be placed on healthy lifestyles. Indeed, the factors associated with DM in this Guinean population are potentially modifiable. The design and implementation of appropriate strategy for early diagnosis and treatment, and population-based primary prevention of DM in these high-risk populations is therefore a public health priority [17]. Mechanisms for effective screening and promotion of proper diet and exercise must be incorporated into existing health services to prevent an expected escalation of DM in Guinea.

Intervention programs designed to reduce waist circumference through lifestyle modification, including exercise and diet, may have important public health significance in reducing the incidence of hypertension and adult-onset DM in these populations [27]. In addition to poverty, African health challenges and solutions are undoubtedly complex, deeply rooted in political, socio-economic, and cultural issues [22].

5. Conclusion

In conclusion, the findings of our study indicate that DM appears to be more frequent than previously thought in rural and urban populations. Further studies in other rural and urban areas and among other socio-ethnic groups are required to obtain an overall picture of the prevalence of DM in Guinea. There is an urgent need for health planners to propose comprehensive strategies to address the problem of DM. Henceforth, prevention should focus primarily on sustaining appropriate lifestyles.

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