Screening for diabetes mellitus in a Nigerian family practice population

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Abstract

Background

Diabetes mellitus is a non-communicable disease with a rising prevalence worldwide. Most of the increase in prevalence is projected to be in the developing countries. As it is recognised that the onset of the disease and its complications predate the symptoms, it is expedient that screening procedures are undertaken to diagnose the disease in the individual as early as possible to minimise the risk of complications. Diabetes mellitus is a chronic disease necessitating life-long therapy, usually with drugs. This creates a life-long financial burden on the family, especially in low socio-economic communities in West Africa, where the majority of the population still lives on less than one dollar a day. This affects the wellbeing of the entire family, hence the need for early detection, prompt and adequate management of the disease and avoidance of its complications.

Methods

The study is an incidental screening to determine the prevalence of diabetes mellitus, its risk factors and the clinical characteristics of diabetics in a Nigerian family practice population. Four hundred and twenty subjects aged 15 years or older were recruited by systematic random sampling in a family practice in South West Nigeria over a three-month period. Data collected include the subjects' socio-demographic data, family history of diabetes mellitus and hypertension, and history of tobacco and alcohol use. The subjects' weight and height were measured and their body mass index (BMI) calculated. Each subject was examined for peripheral neuropathy, lens opacity and hypertension. Fasting blood glucose was measured using a glucometer and urine was tested for albumin. Those with a fasting blood glucose of greater than 6.1 had a fasting blood glucose determination by the standard spectrophotometric method.

Results

Ten (2.38%) subjects were known diabetics, while 57 (13.6%) were known hypertensives. Ten (2.38%) new diabetics were identified, and 7.5% of the females compared to 5.8% of the males were diabetic. Alcohol intake, obesity, age above 44 years and a positive parental history of diabetes were the significant risk factors ($p < 0.01$) for diabetes in the study. Proteinuria and peripheral neuropathy were the significant complications ($p < 0.01$).

Conclusions

It is concluded that diabetes is a common problem in our practice, with a prevalence of 4.76%, half of which was previously undiagnosed. Alcohol intake, obesity, positive parental history and age over 44 years were the identified risk factors. Peripheral neuropathy, proteinuria and high blood pressure were the identified complications. It is recommended that routine screening of people at high risk of diabetes mellitus in family practice be commenced. The glucometer, a relatively cheap item of equipment in the practice, is a highly useful, sensitive and specific tool for this purpose.

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Introduction

The prevalence of diabetes mellitus is rising worldwide in both developed and developing countries.[1] Its worldwide prevalence is about 2%, and the prevalence in Nigeria is 2.2%, which means that about 2.6 million Nigerians are diabetic.[2] This means that about 2.6 million Nigerians are diabetic. It is known that 50% of the affected individuals (about 1.3 million Nigerians) do not even know that they have the disease.[3,4] Complications of diabetes mellitus have been found to set in long before clinical manifestation of the disease.[3,4] The onset of complications of diabetes mellitus can be reduced if the diagnosis is made early and appropriate treatment is commenced promptly. Diabetes mellitus has a serious impact on those affected and their families, hence the need for early detection and prompt and adequate management. Early detection can be enhanced by screening people for the disease on an incidental basis when consulting for other reasons. General practice provides an excellent opportunity for this, as most people consult their GPs for various reasons at least once annually. Furthermore, the glucometer has been found to have a precision similar to that of routine laboratory systems.[5] In addition, an estimation of fasting blood glucose alone has been found to be adequate for diabetes screening.[4,6,7,8] It was found to have a comparable yield to Oral Glucose Tolerance Test OGTT in Ghanaians.[6] Using a simple glucometer, the family physician can easily undertake the screening of at-risk people in his/her practice population with minimal inconvenience.

The family physician is ideally positioned to screen for type 2 diabetes mellitus in view of its familial tendency and particularly as the family assumes responsibility in health interaction as part of its normal functioning.

Objectives

The objectives of the study were to determine the prevalence of diabetes mellitus and identify its risk factors in a general practice population

Methods

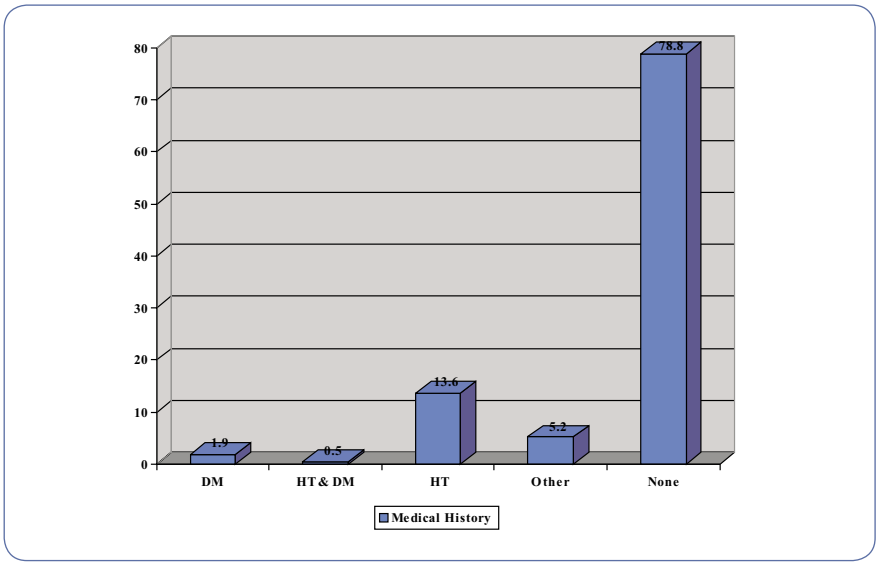
This is a descriptive, cross-sectional, practice-based study of patients 15 years and older attending the General Practice Department of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC) in Ile-Ife, South Western Nigeria. The study was conducted over the three-month period from January to March 2004.

Of 3 250 new attendees for reasons ranging from a medical check-up to illnesses during the study period, a total of 420 patients who consented to participate in the study by providing fasting blood samples were selected by systematic random sampling. Severely ill patients, those who had eaten within 12 hours prior to the evaluation, patients who were dehydrated or on L-dopa-containing drugs were excluded from the study.

Data were collected with the aid of a structured interviewer-administered questionnaire, an AccuChek Active® blood glucose monitor (Serial no: GG03110346; Art. no: 2248891001), Albustix® strips for proteinuria, a bathroom weighing scale, a standiometer and an Accosson® brand mercury sphygmomanometer. The information collected included the age, sex, occupation and marital status of the subjects. The subjects' smoking and alcohol history, as well as their past medical and family history of diabetes and hypertension were obtained. Complications of diabetes mellitus, such as skin infections, foot ulcers, peripheral neuropathy and macrovascular disease were looked for on physical examination and recorded.

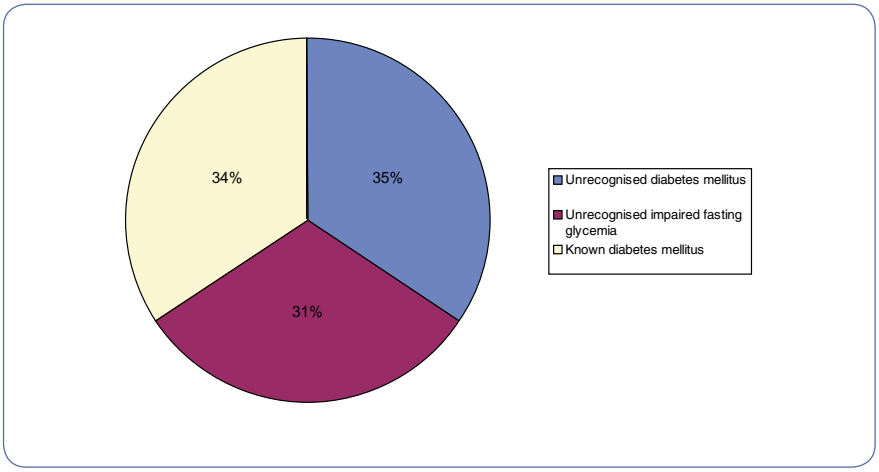
The blood pressure of the subjects was measured in the sitting position using the left arm. The body mass index (BMI), kg/m^2, was calculated for each subject. Subjects were grouped according to the WHO classification of obesity.[9] Blood sugar was determined for each subject using a fresh capillary fasting blood sample by the glucometer method. Patients whose fasting blood sugar level was above 6.1 mmol/l had confirmatory fasting venous blood samples taken for standard spectrophotometric

Figure 1: Past medical history of study respondents



HT = hypertension; DM = diabetes mellitus

Figure 2: Distribution of fasting hyperglycaemia among respondents



laboratory blood sugar determination. Standard precautions and procedures were followed for all measurements.

All data collected were fed into the computer and analysed using the Epi Info 2002 Revision 2 software.[10] Data were presented using relative frequencies, mean, median and mode. The prevalence of impaired fasting glucose and diabetes mellitus was determined. The prevalence of complications in hyperglycaemic and euglycaemic subjects was compared using χ^2 statistics. The relative risk and odds ratio were determined for each risk factor for diabetes and complication. The level of significance was set at $p < 0.05$. Ethical approval was obtained from the OAUTHC ethical committee.

Results

A total of 420 subjects were screened for diabetes mellitus. The majority of the subjects were 45 years or older (56.7%), females (62.9%) and married (63.3%). Only 4% and 1% of the screened subjects had positive parental and sibling history of DM respectively, compared with 6.9% and 3.1% of positive parental and sibling history of hypertension respectively. Figure 1 shows the medical history of the study subjects.

By using the glucometer, it was found that nine (2.9%) subjects had impaired fasting glycaemia, while 20 (4%) were in the diabetic range. The others were euglycaemic. Most (19, 79.2%) of the subjects with hyperglycaemia were females. Figure 2 shows the distribution of subjects with fasting hyperglycaemia. Four subjects whose glucometer readings were higher than 6.1 mmol/l did not come back with a laboratory result, while one had a laboratory fasting blood glucose of 5.3 mmol/l, giving a positive predictive index of 96% (24/25) for the glucometer. Of the 420 subjects, a total of 188 (44.8%) were either overweight (110, 26.2%) or obese (78, 18.6%). Seventeen (58.6%) of the hyperglycaemic subjects were overweight (7, 41%) or obese (10, 59%).

Table I shows that fasting hyperglycaemia was commoner in people 45 years and older (22, 9.2%) than among those 44 years or younger (2, 1.1%). More females (19, 7.2%) were hyperglycaemic than males (5, 3.2%]) Age, sex, alcohol intake, obesity and having a diabetic parent were significantly associated with the presence of diabetes mellitus, as shown in Table I ($p < 0.05$). This table also shows that high diastolic blood pressure ($p = 0.03$) was a significant risk factor for diabetes, but high systolic blood pressure ($p = 0.65$) was not.

Table II shows that all 10 subjects with unrecognised diabetes were 45 years or older, and of these nine (90%) were obese and six (60%) were female. Eight (88.9%) of the nine with unrecognised impaired fasting glycaemia (IFG) were obese and all were females 45 years or older.

Table I: Risk factors associated with hyperglycaemia in the study

Risk factor	Hyperglycaemia+ (FBS > 6.1 mmol/l) n=24	Normoglycaemia (FBS ≤ 6.1) n=392	Statistic
Age(years)			Odds ratio = 0.11
<45	2 [8.3%]	176 [44.9]	[95% CI 0.01 – 0.47]
≥45	22 [91.7%]	216 [55.1%]	$X^2 = 12.35$, p = 0.00
Gender			Odds ratio = 0.44
Male	5 [20.8%]	147 [37.5%]	[95% CI 0.13 – 1.25]
Female	19 [79.2%]	245 [62.5%]	$X^2 = 2.71$, p = 0.09
Smoking			Odds ratio = 2.18
Yes	6 [25%]	52 [13.3%]	[95% CI 0.67 – 6.06]
No	18 [75%]	340 [86.7%]	$X^2 = 2.60$, p =0.1
Alcohol			Odds ratio = 26.61
Yes	20 [83.3%]	62 [15.8%]	[95% CI 8.42 – 109.41]
No	4 [16.7%]	330 [84.2%	$X^2 = 65.14$, p = 0.00
BMI (Kg/m²)			Odds ratio = 2.64
> 25	16 [66.7%]	169 [43.1%]	[95%CI 1.03 – 7.28]
≤ 25	8 [33.3%]	223 [56.9%]	$X^2 = 5.08$, p = 0.02
Positive parental history			Odds ratio = 5.83
Yes	4 [16.7%]	13 [3.3%]	[95% CI 1.26 – 21.09]
No	20 [83.3%]	379 [96.7%]	$X^2 = 10.28$, p = 0.00
Positive sibling history			Odds ratio = 0.00
Yes	0 [0%]	4 [1.0%]	[95% CI 0.00 – -25.58]
No	24 [100%]	388 [99.0%]	$X^2 = 0.25$, p = 0.78
Blood pressure systolic			Odds ratio = 1.22
> 140 mmHg	10 [41.7%]	145 [37%]	[95% CI 0.49 – 3.00]
< 140 mmHg	14 [58.3%]	247 [63%]	$X^2 = 0.21$, p = 0.65
Diastolic			Odds ratio = 2.41
> 90 mmHg	14 [58.3%]	144 [36.7%]	[95% CI 0.98 – 6.02]
< 90 mmHg	10 [41.7%]	248 [63.3%]	$X^2 = 4.48$, p = 0.03

+ Fasting hyperglycaemia confirmed by the laboratory

Table II: Characteristics of the hyperglycaemic subjects by type of hyperglycaemic state*

Characteristic	Unrecognised diabetes n = 10	Unrecognised impaired fasting glycaemia n = 9	Known diabetes n= 10
Age			
45+	10 [100%]	9 [100%]	7 [70%]
BMI (kg/m²)			
> 25	9 [90%]	4 [44.4%]	4 [40%]
≤ 25	1 [10%]	5 [55.6%]	6 [60%]
Gender			
Female	6 [60%]	9 [100%]	5 [50%]
Male	4 [40%]	0 [0%]	5 [50%]
Alcohol intake			
Yes	6 [60%]	9 [100%]	7 [70%]
No	4 [40%]	0 [0%]	3 [30%]
Smoking			
Yes	5 [50%]	0 [0%]	3 [30%]
No	5 [50%]	9 [100%]	7 [70%]
Family history of DM			
Yes	0 [0%]	2 [22.2%]	3 [30%]
No	10 [100%]	7 [77.8%]	7 [70%]
High blood pressure			
Yes	4 [40%]	5 [55.6%]	3 [30%]
No	6 [60%]	4 [44.4%]	7 [70%]

*29 identified with the glucometer

Table III shows that fasting hyperglycaemia, female gender and high blood pressure were the significant characteristics found among those with a positive parental history of diabetes ($p < 0.05$).

Table IV shows that peripheral neuropathy and proteinuria are the most frequent complications of hyperglycemia observed in this study. Of those with unrecognised DM and IFG, five (50%) and none had neuropathy and five (50%) and five (55.6%) had proteinuria respectively.

Table III: Characteristics of the subjects with positive parental history of diabetes

	Positive parental history n = 17	Negative parental history n = 399	Significance
Fasting blood glucose > 6.1 mmol/l < 6.1 mmol/l	4 [23.5%] 13 [76.5%]	20 [5.0%] 379 [95%]	Odds ratio = 5.83 [95% CI = 1.26 – 21.09] $X^2 = 10.28$, p = 0.01
Gender Female Male	15 [88.2%] 2 [11.8%]	249 [62.4%] 150 [37.6%]	Odds ratio = 4.52 [95% CI = 1.03 – 41.16] $X^2 = 4.69$, p = 0.03
Smoking Yes No	1 [5.9%] 16 [94.1%]	57 [14.3%] 342 [85.7%]	Odds ratio = 0.38 [95% CI = 0.01– 2.51] $X^2 = 0.96$, p = 0.28
Alcohol intake Yes No	4 [23.5%] 13 [76.5%]	78 [19.6%] 321 [80.4%]	Odds ratio = 1.27 [95% CI = 0.29 – 4.24] $X^2 = 0.16$, p = 0.43
High blood pressure Yes No	6 [35.3%] 11 [64.7%]	55 [13.8%] 344 [86.2%]	Odds ratio = 3.41 [95% CI = 0.99 – 10.52] $X^2 = 6.03$, p = 0.02
BMI > 25 kg/m² Yes No	9 [52.9%] 8 [47.1%]	176 [41.6%] 223 [58.4%]	Odds ratio = 1.43 [95% CI = 0.49 – 4.15] $X^2 = 0.51$, p = 0.47

Table IV: Relative prevalence of complications of hyperglycaemia in subjects by glycaemic status

Complication	Hyperglycaemia (FBS > 6.1 mmol/l) n = 24	Normoglycaemia (FBS ≤ 6.1 mmol/l) n = 392	Significance
Proteinuria Yes No	10 [41.7%] 14 [58.3%]	32 [8.2%] 360 [91.8%]	$X^2 = 27.97$, p= 0.00
Peripheral neuropathy Yes No	14 [58.3%] 10 [41.7%]	7 [1.8%] 385 [98.2%]	$X^2 = 150.07$, p= 0.00
Foot lesions Yes No	1 [4.2%] 23 [95.8%]	3 [0.8%] 389 [99.2%]	$X^2 = 2.75$, p =0.21
High blood pressure Yes No	9 [37.5%] 15 [62.5%]	105 [26.8%] 287 [73.2%]	$X^2 = 1.30$, p = 0.25

Discussion

In this study, 20 subjects (4.76%) were found to be diabetic. This is higher than the Nigerian national prevalence of 2.2%[2] and the worldwide prevalence of 2%.[11] In 1997, Owoaje ***et al.*** found a prevalence of 2.8% in Ibadan, Nigeria.[12] Olatunbosun and Bella, however, reported a prevalence of 0.8% in the same community in 1998.[13] The marked difference in the proportion of diabetics in this study can partly be explained by the fact that it is a practice-based study in contrast to the others, which were community based. There is, however, a recognised trend of increasing prevalence worldwide.[11,14] The WHO has cited urbanisation as a recognised factor in the increasing prevalence of diabetes worldwide.[15] The greatest increase in the prevalence of type 2 diabetes is expected from developing countries as a direct result of increasing urbanisation.[15,16] A review of studies on the prevalence of diabetes in adults in Africa by Unwin ***et al.*** demonstrated a rising prevalence across the continent.[15] The prevalence of type 2 diabetes of 6.3% in Ghana,[17] and 8% in Cape Town and Australia, are much higher than in the present study.[1,18] Ghana and Nigeria, both in West Africa, have similar socioeconomic environments, while South Africa and Australia are socioeconomically more developed.

In this study, the positive predictive index of the glucometer was 96%. Bitzen and Schersten found no difference in specificity and predictability compared with the standard laboratory method.[19] Previous studies have demonstrated the comparability of the glucometer and standard laboratory methods in blood glucose estimation.[6,20] Ajala ***et al.*** compared three brands of glucometer with the standard laboratory method and got a correlation coefficient of 0.990 for Accutrend Alpha®, manufactured by Roche Diagnostics, which manufactured the AccuChek Active® glucometer used in this study.[6] Murphy ***et al.*** got a correlation coefficient of 0.85 and a sensitivity of 92% with the AccuChek II glucometer in 15 Alaskan villages.[20]

This study identified ten subjects (2.4%) with previously undetected diabetes mellitus and a further nine (2.1%) who had unrecognised impaired fasting glycaemia. This agrees with the findings of previous studies.[11,21,22]. Olatunbosun et al., studying 998 civil servants in Ibadan, found a prevalence of 0.8% and 0.5% for diabetes mellitus and previously undiagnosed diabetes mellitus respectively.[23] The finding of 2.4% as the proportion in the study population with unrecognised diabetes mellitus in our study is highly comparable to the findings of Elbagir ***et al.***,[21] who found 2.2% in Sudan, and Greaves ***et al.***,[22] who found between 2.6% and 4.7% among groups of patients with different risk factors in a UK family practice setting. In the United Kingdom Prospective Diabetes Study UKPDS, Edelman et al. found a 4.5% prevalence of unrecognised diabetes mellitus in an out-patient clinic population in the United States.[24] In our study, 50% of the diabetics had not been diagnosed previously, which agrees with the projection of King ***et al.***,[11,25] Mbanya ***et al.***[26] and Amoah ***et al.***,[17] who report that between 30 and 70% of diabetics are previously undiagnosed and asymptomatic.

Alcohol was found to be positively associated with diabetes mellitus in this study. Most (96.5%) of the subjects who used alcohol in this study took less than five units of alcohol daily. An association between alcohol and diabetes has been documented by various authors.[27,28] There is a non-linear relationship between alcohol intake and the risk of type 2 diabetes.[28] Wei ***et al.***[29] and Nakanishi ***et al.***[30] observed that alcohol excess or abstinence increases the risk of developing diabetes. Levitt et al., on the other hand, reported that alcohol intake was not a significant risk factor for diabetes mellitus in South Africa.[18]

Seventeen of the 29 hyperglycaemic subjects (75.9%) were obese. Several researchers have demonstrated a significantly higher prevalence of type 2 diabetes among the obese compared with the non-obese.[13,18,23,31,32] Olatunbosun et al. observed that high body mass index is associated with increased blood glucose in their study in Ibadan, Nigeria.[23] Owoaje ***et al.***, in another study in Ibadan, reported a 1.5-fold increase in the risk of developing elevated fasting blood glucose in the obese.[13] Obesity is known to be a consistent risk factor for type 2 diabetes in people of African origin living in Cameroon, Jamaica and Britain.[31] Hillier ***et al.*** observed that obesity was a continuous risk rather than a threshold risk for diabetes onset.[32] In the present study, nearly all subjects (89.5%) with previously unrecognised fasting hyperglycaemia compared with 50% of known diabetics were obese. Edelman ***et al.*** found obesity and hypertension to be significant risk factors for unrecognised diabetes in an outpatient setting in Durham, USA.[24]

Fasting hyperglycaemia is more common among females than males in this study (female:male = 1.7:1). The Nigerian National Non-communicable Disease Survey and other studies have made similar observations.[2,33] This, however, contrasts with the report of Amoah et al., who observed a slightly higher preponderance among males than females.[17] Our finding may be explained by the finding of a significantly higher proportion of obese females than males in this study.

There is strong evidence in the literature that type 2 diabetes is commoner among first-degree relatives of affected individuals.[23,24,33] This has been corroborated in this study by a strong positive association between fasting hyperglycaemia and parental history of type 2 diabetes (Odds ratio 5.8, CI 1.3-21.1). However, the present study could not demonstrate an association with a positive sibling history of type 2 diabetes.

Complications associated with diabetes mellitus in this study were peripheral neuropathy, proteinuria and high blood pressure ($p < 0.05$). Reenders ***et al.*** reported that 68% and 57% of their subjects with NIDDM in GP settings in the Netherlands had neuropathy and nephropathy respectively.[34] Similar findings have been reported by other workers.[35,36,37] Harris ***et al.*** observed that complications may develop before a clinical diagnosis is made.[38] The findings of this study also agree with this observation.

High diastolic blood pressure was significantly and positively associated with fasting hyperglycaemia in this study ($p = 0.03$). In an out-patient clinic population akin to the present study population, Edelman ***et al.*** found hypertension to be associated with unrecognised diabetes ($p = 0.004$).[24] In agreement with the finding of the current study, Hillier ***et al.*** observed that diastolic hypertension but not systolic hypertension was associated with type 2 diabetes mellitus.[32] The association of fasting hyperglycaemia and elevated blood pressure in this study is further supported by Agaba ***et al.***, who reported hypertension in half of diabetics in a study in Jos, Nigeria.[39]

Conclusions

Diabetes mellitus is a common, non-communicable disease among patients presenting at our Family Practice Clinic, occurring in 4.8% of new patients, half of whom had not been diagnosed previously. It was more common in the females, with a male:female ratio of 1:1.7, and in people older than 44 years, with all those with unrecognised diabetes mellitus being above this age.

Obesity, having a diabetic parent and alcohol intake were associated with diabetes mellitus in this study. Proteinuria and peripheral neuropathy develop in the sub-clinical phase of the disease, being present in 41.7% and 58.3% of the subjects with fasting hyperglycaemia respectively.

The glucometer was found to be a reliable tool for screening patients for diabetes, with a positive predictive index of 96% in this study.

Declarations

Ethical approval for this study was obtained from the OAUTHC ethical and research committee. Funding for the study was provided by the authors. There is no conflict of interest, as we have no financial or personal relationships that may have inappropriately influenced us in writing this paper.

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