EVALUATION OF NUTRITIONAL STATUS AND ITS RELATIONSHIP WITH FUNCTIONAL STATUS IN OLDER CITIZENS WITH DIABETES MELLITUS USING THE MINI NUTRITIONAL ASSESSMENT (MNA) TOOL – A PRELIMINARY INVESTIGATION

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Abstract: BACKGROUND: Despite all that is known about diabetes mellitus, little is known about the nutritional status of older adults with this condition. OBJECTIVE: To determine whether older people with diabetes mellitus are malnourished when compared with non-diabetic subjects, to evaluate the MNA in this group, and to assess the possible relationship between nutritional impairment and function. DESIGN: A case controlled study. Community-dwelling volunteers were selected randomly from 2 general practice registers. 35 people over the age of 65, with diabetes mellitus, were age and sex matched with 35 control subjects without diabetes. The major outcome measures were: the MNA questionnaire, anthropometric measurements, serum albumin, transferrin, Barthel Index, Nottingham Extended ADL score and handgrip. RESULTS: The diabetic group scored significantly lower on the MNA than the control group (p<0.01), but this was mainly indicative of many of the diabetic subjects scoring within the “at risk” category of the tool. Those in the diabetic group also had significantly lower albumin scores (P<0.05) when compared with the control group. Within the diabetic group, and in the study group as a whole, the MNA scores were significantly correlated with Barthel Index (p<0.01), Nottingham Extended ADL score (p<0.01) and handgrip (p<0.01). CONCLUSION: Community dwelling elderly subjects with diabetes may be at risk of malnourishment when compared with non-diabetic citizens. There is probably a causal relationship between malnourishment and functional decline in this group. Further research is needed, where the prevalence of malnourishment is higher, to fully evaluate the MNA in people with diabetes.

Key Words: Diabetes, nutrition, ageing, MNA, function, elderly.

Introduction

Diabetes Mellitus is said to occur in up to 18% of the population aged 65 and over (1). It is known that older patients with diabetes mellitus are at risk of functional decline over time due to a number of reasons, including the complications of the disease itself (2). There is also an associated reduction in function in people with diabetes mellitus with increasing age; the incidence of both functional decline and diabetes mellitus increase independently of one another with increasing age, so as the diabetic ages, the decline in function is compounded. Other factors, such as the high risk of co-morbidities, medications and the increased risk of carer strain, contribute to this (2). Despite all that is known about diabetes, little is known about the nutritional status of older people with this metabolic condition, and its contribution to functional decline.

There is much literature published on the role of dietary therapy in the management of people with diabetes, but most studies focus on the middle-aged patient. There is increasing evidence to suggest that diabetes mellitus has a different presentation, complication rate and management (including the role of dietary therapy) in the elderly population (1). Elderly people with diabetes share many of the nutritional problems of older people with chronic diseases, but do they have a nutritional deficiency which is specific and related to the disease itself, separate from reduced vitamin C levels, which are a common finding (3). Insulin deficiency is very similar to malnutrition. Both are catabolic states that lead to increased cell turnover, and subsequent demand for, nutrients, vitamins and minerals. Zinc loss, for example, with its anorexigenic consequences, is a particular risk which is well documented (1).

Despite the strong theoretical relationship between malnutrition and diabetes in old age, the protein energy status of this group remains unknown. This may, in part, be due to the fact that assessing the nutritional status of older people remains a clinical and scientific challenge, since no single “gold standard” test exists (4). The Mini Nutritional Assessment (MNA) tool (scale 0 – 30) (5) has been developed in order to permit early nutritional intervention when needed, without needing to involve a specialist nutrition team (6). It has been extensively evaluated, in a variety of settings, including healthy elderly people, pre-operative patients, nursing home residents, frail elderly people (5-8) and, more recently, in elderly orthopaedic patients (9).

The aim of this study was to investigate the nutritional status of older adults with diabetes mellitus using the MNA and to examine a possible relationship with function.
FUNCTIONAL STATUS IN OLDER CITIZENS WITH DIABETES MELLITUS

Methods

Subject Recruitment
This was a case controlled study, whereby subjects with diabetes mellitus, over the age of 65, were sex and age (within 2 years) matched with non-diabetic volunteers. It was decided that subjects who were living within their own homes should be recruited, since this reduced the possibility of confounding variables, such as acute illness, which would significantly alter nutritional status. Two general practice surgeries were contacted, chosen for their close proximity to the hospital where the researchers were based. Lists were obtained from the practice managers of all people over the age of 65. From these lists people with diabetes mellitus were identified. People who were living in residential or nursing homes were excluded (to reduce confounding variables). All people with diabetes mellitus were contacted by post and asked to volunteer for the study. Of those who were willing to participate, an initial 35 people were selected using random number tables (10). If a volunteer met the exclusion criteria following analysis of the data collected, that data was excluded and random number tables were used to select a further subject. Data was collected until 35 data sets were available for analysis.

From the controls list, people who were living in residential and nursing homes were excluded. The list was examined such that potential controls (in terms of age, gender and same general practice) for those diabetics in whom data had been collected, could be identified. These people were all contacted by post requesting participation in the study. Of the people who replied indicating that they would be willing to participate, 35 age and sex matched controls were selected using random number tables (10). If, after completion of data collection, the exclusion criteria were met, that individual was excluded and a further subject randomly selected. Thus 2 groups of data were collected, one group of 35 volunteers with diabetes mellitus and one group of 35 without. Where each person was age and sex matched with a diabetic from the same general practice register.

Written informed consent was obtained from all people who had data collected.

Exclusion criteria
People were excluded if they had recognised indicators of possible nutritional impairment (11). Therefore they were excluded if they scored 15 or more on the Yesavage Geriatric Depression Scale (30 point) (12) or had known depression for which they were receiving treatment. Volunteers were also excluded if they had a known eating disorder, known swallowing problems or were receiving artificial feeding. A Folstein mini-mental state examination (13) was conducted for each individual and those who scored 23 or less were excluded, as were people with known prior cognitive impairment. Those with known malabsorption or on a low salt or cholesterol – lowering diet were excluded also. Volunteers were asked to bring a recently collected urine sample with them and this was examined using BM-Test-5L dipsticks (Boehringer Mannheim). If this was positive for protein, the subject was excluded from the study on the grounds that this may affect the serum albumin level. Subjects were also excluded if they were found to have abnormal thyroid function on testing or hypercalcaemia (as a screen for hyperparathyroidism) (11). Volunteers in the control group were excluded if they had an elevated random serum glucose or glycosylated haemoglobin.

Local research ethics committee approval was granted by University Hospital Birmingham NHS Trust. Power calculations, using previous validation data (5), showed that 35 pairs of people were needed to show a significant difference in Mini Nutritional Assessment scores to a power of 80% (10).

Nutritional Assessment

Anthropometry
Weight, height, BMI (weight[kg]/height2[m2]) or demiquet (weight[kg]/demi-span x 2)[m2]) where the volunteer was unable to stand (14), triceps skinfold thickness (TSF) and mid-arm circumference (MAC) were measured in the standard manner (15). Mid-calf circumference was measured as part of the MNA.

Clinical Laboratory Tests
Blood samples were obtained from the volunteers and subsequently processed by the laboratory for random glucose analysis, glycosylated haemoglobin, TSH, free T4 and calcium (as part of the exclusion criteria) and albumin and transferrin as part of nutritional evaluation (9).

All volunteers completed the Mini Nutritional Assessment tool (5).

Functional Analysis
In order to evaluate function in both groups, all volunteers completed the Barthel Index (16), the Nottingham Extended Activities of Daily Living (NEADL) scale (17) (which has previously been widely validated)(18,19) and also handgrip strength. Grip strength is measured by squeezing a hand grip attached to a force gauge with all one’s strength, and is the most common method of determining muscle function in general use (20). Here, handgrip was measured using an Accoson Aneroid Limpet hand – model sphygmomanometer. The cuff was inflated to 20 mmHg and the subject given it to grasp in their dominant hand. Where the dominant hand was no longer available due to pathology on that side, the non-dominant hand was used. The subject was told to exert a maximum grip on the inflated cuff (”squeeze as hard as you can”) and the highest of 3 readings was recorded in mmHg. The initial 20 mmHg was subtracted from that to give the true reading.

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**Statistical Analysis**

Data was statistically analysed using SPSS for windows version 10. Statistical tests were performed to evaluate normality of distribution. Spearman's correlation co-efficient was used for correlations (non-parametric testing). The Mann–Whitney U, Chi-squared, Fischer's exact and Kruskal-Wallis tests were used for comparing groups of data. A p value of < 0.05 was taken to indicate statistical significance.

**Results**

Ninety sets of data were collected in total. In the diabetic group 10 people were excluded because of a GDS ≤ 15, 3 people were excluded due to MMSE ≤ 23 and 3 people were excluded due to proteinuria on dipstick testing. In the control group, 2 people were excluded due to GDS ≤ 15, and 2 people were excluded due to MMSE ≤ 23. No one in the control group was excluded due to proteinuria nor due to elevated random serum glucose or glycosylated haemoglobin. This is illustrated in Table 1.

**Table 1**

Schematic representation of data collected

<table>
<thead>
<tr>
<th>Diabetics</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>109 people contacted</td>
<td>2643 people contacted</td>
</tr>
<tr>
<td>80 people responded</td>
<td>743 people responded</td>
</tr>
<tr>
<td>68 willing</td>
<td>204 willing</td>
</tr>
<tr>
<td>51 sets of data</td>
<td>39 sets of data</td>
</tr>
<tr>
<td>-10 x GDS ≥ 15</td>
<td>-2 x GDS ≥ 15</td>
</tr>
<tr>
<td>-3 x MMSE ≤ 23</td>
<td>-2 x MMSE ≤ 23</td>
</tr>
<tr>
<td>-3 x proteinuria</td>
<td>-0 x proteinuria</td>
</tr>
<tr>
<td>35 sets of date</td>
<td>35 sets of date</td>
</tr>
</tbody>
</table>

The mean age in the diabetic group was 75.7 (SD 6.5, range 65 – 90) and the mean age in the control group was 75.9 (SD 6.5, range 65 – 90). In the diabetic group 12 (34%) people had diet controlled diabetes, 13 (37%) had tablet controlled diabetes and 10 (29%) were insulin treated. 48.6% of the total group of people with diabetes reported that they had never seen a dietician. 45.7% had seen a dietician more than a year ago, with only 5.7% having seen a dietician in the preceding 12 months. 25.7% said that they never followed a diabetic diet, 48.6% said that they only followed the diet sometimes and the remaining 25.7% said that they always followed the diabetic diet.

Descriptive statistics for the study groups for nutritional evaluation are illustrated in Table 2.

**Table 2**

Nutrition outcome measures

<table>
<thead>
<tr>
<th></th>
<th>Diabetic Group n = 35</th>
<th>Control Group n = 35</th>
<th>Statistical Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>range</td>
<td>mean</td>
</tr>
<tr>
<td>Body Weight (Kg)</td>
<td>79.97</td>
<td>71.13-106</td>
<td>76.56</td>
</tr>
<tr>
<td>BMI (Kg/m2)</td>
<td>28.83</td>
<td>27.0-37.9</td>
<td>28.29</td>
</tr>
<tr>
<td>MNA Screen (max 12)</td>
<td>12.23</td>
<td>7-14</td>
<td>13.00</td>
</tr>
<tr>
<td>MNA Total (max 30)</td>
<td>25.36</td>
<td>16.5-30</td>
<td>27.7</td>
</tr>
<tr>
<td>Albumin (g/L)</td>
<td>41.8</td>
<td>29-49</td>
<td>43.6</td>
</tr>
<tr>
<td>Transferrin (g/L)</td>
<td>2.65</td>
<td>1.97-3.52</td>
<td>2.6</td>
</tr>
<tr>
<td>Triceps Skinfold (mm)</td>
<td>16.45</td>
<td>3.2-37.5</td>
<td>14.09</td>
</tr>
<tr>
<td>Mid-arm 260.2 circumference (mm)</td>
<td>210-360</td>
<td>33.59</td>
<td>295.5</td>
</tr>
</tbody>
</table>

NS = Not Significant

When compared with reference data (21), 8 people in the group with diabetes (23%) had a BMI above the 95th percentile, as did 7 people in the control group (20%). None of the volunteers in either group had a BMI below the 5th percentile. There were no statistically significant differences between the two groups in any of the anthropometric measurements. The group with diabetes scored on average lower scores on the MNA when compared with the group without. The means in both groups are, however, both above the cut off indicator for risk of nutritional impairment and hence caution is taken in interpreting these results. In fact the difference between the groups is representative of the number of people in the diabetic group scoring within the "at risk" category. 9 (26%), compared with the number in the control group scoring in this range, 2 (0.06%).

When examining the functional data, there was a difference in the functional abilities of the two groups, in that the diabetic group scored significantly lower on the Barthel Index and The Nottingham EADL score. This is shown in table 3.
FUNCTIONAL STATUS IN OLDER CITIZENS WITH DIABETES MELLITUS

Table 3
Functional outcome measures

<table>
<thead>
<tr>
<th></th>
<th>Diabetic Subjects n = 35</th>
<th>Control Subjects n = 35</th>
<th>Statistical Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean SD range</td>
<td>mean SD range</td>
<td>p = 0.034</td>
</tr>
<tr>
<td>Barthel Index (Max 20)</td>
<td>17.8 3.76 5-20</td>
<td>19.23 3.17 16-20</td>
<td></td>
</tr>
<tr>
<td>NEADL (Max 22)</td>
<td>16.14 6.66 0-22</td>
<td>19.69 3.17 10-22</td>
<td>p = 0.016</td>
</tr>
<tr>
<td>Handgrip (mmHg)</td>
<td>250.74 95.80 102-368</td>
<td>282.97 68.66 72-368</td>
<td>Not significant</td>
</tr>
</tbody>
</table>

Using the group as a whole, as well as examining the diabetic and control groups individually, a significant relationship between the MNA score and functional capabilities could be demonstrated. This is illustrated in table 4.

Table 4
The relationship between MNA and function
(where r = Spearman’s rho)

<table>
<thead>
<tr>
<th></th>
<th>Whole group n = 70</th>
<th>Diabetic group n = 35</th>
<th>Control group n = 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relationship between MNA and Barthel Index</td>
<td>r = 0.402 / p &lt; 0.01</td>
<td>r = 0.568 / p &lt; 0.01</td>
<td>r = 0.048 / Not significant</td>
</tr>
<tr>
<td>Relationship between MNA and NEADL</td>
<td>r = 0.624 / p &lt; 0.01</td>
<td>r = 0.650 / p &lt; 0.01</td>
<td>r = 0.502 / p &lt; 0.01</td>
</tr>
<tr>
<td>Relationship between MNA and Handgrip</td>
<td>r = 0.520 / p &lt; 0.01</td>
<td>r = 0.642 / p &lt; 0.01</td>
<td>r = 0.297 / Not significant</td>
</tr>
</tbody>
</table>

Furthermore, Barthel was found to be highly correlated with the Nottingham EADL score (Spearman’s r = 0.706, p < 0.01). This correlation was also present when the diabetic group (r = 0.774) and control group (r = 0.574) were examined separately. Both the Barthel score and the Nottingham EADL score were correlated with handgrip, when the group was examined as a whole (Barthel r = 0.612, NEADL r = 0.631, p < 0.01 for both). These correlations were also present when the groups were examined independently of one another. In the diabetic group Barthel was correlated with handgrip, r = 0.675, and Nottingham EADL was correlated with handgrip, r = 0.6. In the control group Barthel was correlated with handgrip, r = 0.438 and Nottingham EADL was correlated with handgrip, r = 0.619. All these correlations were statistically significant at the p < 0.01 level.

Discussion

The first point of note is the possible selection bias within the study groups. Both groups consisted of self-selecting older people from a proportionately affluent area in Birmingham, surrounding the University hospital. It is likely, therefore, that these people were in better health and therefore the prevalence of malnutrition was likely to be lower than is representative of a population of community dwelling older people. The group were, in fact, a comparatively very well nourished group, as evidenced by many scoring over the 95th percentile for their anthropometric measurements. This observation probably lead to an diminishment in the differences between the two groups. Despite this, however, there were disparities between them. The group with diabetes was a much more functionally impaired group, having lower mean Barthel scores, lower handgrip strength and lower mean Nottingham Extended ADL scores.

Unfortunately, the prevalence of malnutrition (as evidenced by low albumin and transferrin, and anthropometric data below the 5th centile), was not high enough to confidently comment on the validity of the MNA as an assessment tool here, although this has been done extensively elsewhere. Given this, and the small sample size, the results merely give us an indication of what further research may show. There was a significant difference between the two groups in terms of MNA score, although the main difference came within the area of “at risk” of nutritional impairment. This difference is emphasised by the fact that the groups were not significantly different from one another in terms of anthropometric measurements. In addition, the MNA scores were not significantly correlated with any of the individual anthropometric or laboratory investigations alone, although this would probably be expected given that the MNA is an overall nutritional assessment, encompassing all areas of nutritional evaluation. The group with diabetes did have significantly lower albumin levels, although sub-clinical renal disease could not be excluded.

The close correlation between the functional indices and the MNA scores might be interpreted as a function of there being lower MNA scores in the diabetic group, which were more functionally disadvantaged. However, this correlation was present when the groups were looked at separately, indicating a likely association between nutritional impairment and functional impairment in both people with diabetes mellitus, and those without. The fact that there were correlations with all the functional indices in the group with diabetes and only the NEADL in the control group, and that the correlations were stronger in the diabetic group, indicates that it is likely that there is an association between functional impairment and nutritional impairment in people with diabetes.

Also of note, the Nottingham Extended ADL score was well correlated with the Barthel Index, in both the group as a whole and the groups individually, and its use as an instrumental activities of daily living score in both people with diabetes and community dwelling elders is advocated. There was also a close correlation in the course of this study between handgrip measurements and the Barthel Index score and Nottingham EADL score, indicating that this was a valid and useful method of assessing function in both people with diabetes and those without, who were living at home.

It is, however, important that interpretation of these
results be taken tentatively, given the low prevalence of nutritional impairment and the small sample size.

**Conclusion**

Older adults with diabetes mellitus appear to be at risk of nutritional impairment compared with non-diabetic counterparts. Our data also suggests that a relationship between nutritional impairment and functional decline in subjects with diabetes can also be demonstrated. Since older diabetic subjects often have considerable evidence of their co-morbidities and long-term vascular complications, which can affect functional status, measurement of nutritional status in diabetics assumes greater importance. Further research is needed, in settings where the prevalence of nutrition may be higher, and any differences may be amplified, and also with larger numbers of people, to further evaluate this hypothesis.

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**References**