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Younger people with Type 2 diabetes have poorer self-care practices compared with older people: results from the Australian National Diabetes Audit

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Abstract

Aim This cross-sectional study compares the self-care practices of younger and older people with Type 2 diabetes.

Methods Data were analysed from the Australian National Diabetes Audit (ANDA) including 2552 adults with Type 2 diabetes from Australian Diabetes Centres. Pre-specified demographic and clinical variables were obtained. Self-care variables (physical activity, following dietary recommendations, medication adherence and monitoring blood glucose levels) were compared in people ≤ 64 and > 64 years of age.

Results Mean age (± SD) of participants was 63 ± 13 years overall, 53 ± 9 years for the younger group and 73 ± 6 years for the older group. A greater proportion of younger people had HbA_{1c} levels > 53 mmol/mol (> 7.0%) (76% vs. 68%), reported difficulty following dietary recommendations (50% vs. 32%) and forgetting medications (37% vs. 22%) compared with older people (all *P*-values <0.001). A smaller proportion of younger compared with older people reported monitoring their blood glucose levels as often as recommended (60% vs. 70%, $P < 0.001$). Similar proportions of people aged ≤ 64 and > 64 years required insulin therapy (59% vs. 57%, $P = 0.200$). Younger age was associated with a twofold increase in the odds of not following the recommended self-care practices after adjustment for gender, smoking, insulin therapy, depression and allied health attendance (all $P < 0.001$).

Conclusions Despite shorter diabetes duration, younger age was associated with worse glycaemic control and poorer diabetes self-care practices among people with Type 2 diabetes. Targeted strategies are required to optimize diabetes self-care practices and thereby glycaemic control.

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Introduction

The prevalence of Type 2 diabetes mellitus is expected to rise exponentially to affect 642 million individuals worldwide by 2040 [1]. This is largely driven by ageing, obesity and sedentary lifestyles. Lifestyle changes and self-care practices are critical to the optimal management of diabetes. These include engaging in sufficient physical activity, monitoring blood glucose levels, following dietary recommendations and medication adherence.

Engaging in self-care practices has been shown to greatly improve the quality of life of people with Type 2 diabetes [2]. Diabetes self-care practices may identify problem areas in the management of Type 2 diabetes, facilitate better glucose control, and reduce short and long-term complications of poor glycaemic control. Optimal diabetes self-care practices are associated with decreased complications [3], improved quality of life [2], reduced hospital admission [4] and reduced mortality [5].

Traditionally a disease of middle and older age, Type 2 diabetes is increasingly diagnosed in younger people [6]. Younger people are known to have poorer glycaemic control than older people [7], which places them at particularly high risk of complications given the longer lifetime diabetes duration expected. This may be due to differences in self-care practices among younger and older people. Despite increases in diabetes prevalence among younger people, there are relatively little data exploring the diabetes self-care practices

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What's new?

- There are relatively little data exploring diabetes self-care practices in relation to age.
- Previous studies are inconsistent, with positive, negative or no associations between age and self-care practices reported.
- We report a large national cross-sectional study of people with Type 2 diabetes with information on many variables likely to impact on self-care practices.
- Younger age was associated with a twofold increase in the odds of not following the recommended self-care practices.
- Despite shorter diabetes duration, younger age was associated with worse glycaemic control.

in relation to age. Further, previous studies are inconsistent, with positive [8], negative [9] or no [10] associations between age and self-care practices reported.

We hypothesized that there are age-related differences in self-care practices, which contribute to poorer glycaemic control among people with Type 2 diabetes. This study investigates differences in following dietary recommendations, performing sufficient physical activity, monitoring blood glucose levels as recommended, taking prescribed medications and achieving HbA1c targets among younger and older people with Type 2 diabetes attending diabetes centres.

Methods

Data were analysed from the Australian National Diabetes Audit (ANDA) including people with Type 2 diabetes from 50 diabetes centres across Australia during the 1-month survey period in May/June 2016. De-identified data were sourced from participating diabetes centres. People were under the care of endocrinologists, general specialists and general practitioners (GPs). The state and territory location of participating sites is presented in Tables 1–3A–A. The Australian National Diabetes Audit was approved by the Monash Health Human Research Ethics Committee.

Explanatory variables

Pre-specified demographic (gender, date of birth) and clinical variables (diabetes duration, smoking, health professional attendance, HbA_{1c}, physical activity, diet and medication adherence) were obtained for people with Type 2 diabetes. Health professionals from participating centres interviewed patients, reviewed medical records, current medications and pathology results, before entering the information in a standardized data collection form. All missing data, invalid entries and discrepancies were clarified with the patients' treating centre. Age at survey was calculated as date of survey (2016) minus date of birth and categorized as ≤ 64 or > 64 years, based on the median age of the cohort. Diabetes duration was calculated as date of survey minus date of diabetes diagnosis. Smoking status was categorized as current or nil smoking at the time of survey. Own Health State Rating was determined on a visual analogue scale (0–100) of people's subjective assessment of their health on the day of survey. The Brief Case find for Depression (BCD) was administered to screen for depression [11]. People were considered at high risk of depression if they scored at least two positive answers, one in each category of the BCD. The Diabetes Distress Score 17 (DDS17) was administered to screen for diabetes-related distress [12]. If at least one of two screening questions was positive, people were asked to complete the DDS17 questionnaire. This questionnaire assesses difficulties specifically related to diabetes (emotional burden, physician-related distress, regimen-related distress and interpersonal distress) experienced during the past month, graded on a Likert scale from 1 (not a problem) to 6 (very serious problem). An overall mean score < 2.0 indicates little to no distress, a score of 2.0–2.9 indicates moderate distress and a score ≥ 3.0 indicates a high level of distress [13]. Diabetes distress was considered as a categorical variable, with people deemed to have diabetes distress if DDS17 scores were ≥ 3.

Outcome variables

The self-care outcome variables were sufficient physical activity (defined as ≥ 150 total min/week as per National Physical Activity Guidelines for Australians [14]), monitoring blood glucose levels as recommended by the patients' health practitioner (categorized as yes/no/unsure of recommendations), difficulty adhering to the recommended diabetes diet (categorized yes/no), medication adherence (categorized yes/no) and HbA_{1c} (categorized as > 53 mmol/mol (> 7.0%) or ≤ 53 mmol/mol (≤ 7.0%).

Statistical analysis

Categorical variables were summarized as percentages and differences between subgroups analysed using χ^2 test. Continuous variables were reported as means with standard deviations (SD) or as medians with interquartile ranges (IQR) and tested for normality to determine appropriate statistical analysis (parametric or non-parametric). Subgroup analyses were performed using *t*-tests for normally distributed data and Mann–Whitney *U* tests for non-normally distributed data. Logistic regression was used to examine factors (age, diabetes duration, gender, smoking, insulin therapy, depression and health practitioner attendance) associated with self-care practices (as per the categories defined above). The selection of variables was based on identifying all measured

clinical variables of known or suspected prognostic importance for the outcomes of interest (and/or exhibiting *P*-value < 0.10 on univariable analysis). Sensitivity analyses examined the effect of excluding people with diabetes of < 2 years' duration, who may have not yet had opportunity to modify self-care practices and achieve targets. A two-sided significance level of 0.05 was considered statistically significant. All analyses were performed using Stata software version 14.2 (StataCorp, College Station, TX, USA).

Results

Data from 2552 adults with Type 2 diabetes were analysed. Most people were born in Australia (65%) followed by England (4%) and New Zealand (3%); 5% of people required an interpreter at their consultations. The clinical characteristics of participants, stratified by age, are displayed in Table 1. Mean (± SD) age of participants was 63 ± 13 years overall; 53 ± 9 years for the younger group and 73 ± 6 years for the older group ($P < 0.001$). Mean diabetes duration was 9 ± 8 years for younger people and 15 ± 10 years for older people ($P < 0.001$). A greater proportion of younger compared with older people had HbA_{1c} levels > 53 mmol/mol (> 7.0%) (76% vs. 68%, $P < 0.001$). Mean own health rating was lower for younger compared with older people (63 ± 20 vs. 67 ± 20, $P < 0.001$). Similar proportions of younger and older people required insulin therapy (58% vs. 59%, $P = 0.561$).

Table 1 Baseline characteristics by age group (< 60 years compared with ≥ 60 years)

Characteristic	Age ≤ 64 years	Age > 64 years	*P*-value*
Participants, *n* (%)	1208 (53)	1344 (47)	
Age to 2016 (years), mean (SD)	53 (9)	73 (6)	< 0.001
Gender (male), *n* (%)	696 (52)	701 (58)	0.001
Non-English speaking†	56 (4)	70 (6)	0.057
Diabetes duration (years), mean (SD)	9 (8)	15 (10)	< 0.001
HbA_{1c} (mmol/mol), mean (SD)‡	71 (22)	62 (18)	< 0.001
HbA_{1c} (%), mean (SD) ‡	8.7 (2.0)	7.9 (1.6)	< 0.001
Above target HbA_{1c} (53 mmol/mol; 7.0%), *n* (%)	940 (76)	742 (66)	< 0.001
Current smoking, *n* (%)	237 (18)	77 (6)	< 0.001
Management method			
Insulin, *n* (%)	778 (58)	713 (59)	0.561
Self-care, *n* (%)			
Insufficient physical activity§	854 (64)	737 (61)	0.247
Difficulties following dietary recommendations	649 (48)	350 (29)	< 0.001
Don't have enough time to prepare healthy meals	229 (35)	67 (19)	< 0.001
Costs too much to eat well	245 (38)	71 (20)	< 0.001
Don't know what foods are best to eat	191 (30)	98 (28)	0.129
Eat out a lot and find it hard to eat well	158 (24)	65 (19)	0.038
Blood glucose testing, *n* (%)			< 0.001
Tests blood glucose level as often as recommended	825 (32)	868 (72)	
Does not check blood glucose level as often as recommended	429 (32)	260 (22)	
Unsure of recommendation	82 (6)	70 (6)	
Forgets medications, *n* (%)	462 (34)	241 (20)	< 0.001
Health professional attendances, *n* (%)¶			
Diabetes specialist review	67.6 (68)	748 (62)	0.003
Diabetes educator review	1023 (76)	838 (70)	< 0.001
Diabetes specialist and/or diabetes educator review	1236 (92)	1107 (92)	0.873
Dietitian	759 (57)	521 (43)	< 0.001
Quality of life			
Own health state rating (0–100), mean (SD)	63 (20)	67 (20)	< 0.001
Emotional health, *n* (%)			
Diabetes distress**	141 (11)	37 (3)	< 0.001
Depression††	487 (36)	267 (22)	< 0.001
Treatment for depression‡‡	422 (31)	206 (17)	< 0.001

*Categorical variables were presented as n (%) and continuous variables as mean (SD) or median (IQR), as appropriate. Categorical variables were assessed with the chi-squared test. Continuous variables were tested for normality, analyses were performed using *t*-tests for normally distributed data and Mann–Whitney *U* tests for non-normally distributed data. †Defined as requirement of interpreter for appointment.
‡Within 6 months of survey.
§Sufficient physical activity for health benefit is defined as ≥ 150 total min/week (The National Physical Activity Guidelines for Australians).
¶Attended within the last 12 months.
**As indicated by Total Diabetes Distress 17 Score.
††As indicated by the Brief Case-Find for Depression (BCD).
‡‡Taking antidepressant medication and/or undergoing counselling.

Diet adherence

Overall, 39% of people reported difficulty following the recommended diet (48% of the younger group and 29% of the older group, $P < 0.001$) and 49% had been reviewed by a dietitian in the last 12 months (57% and 43% for younger and older people respectively, $P < 0.001$). Reasons given for difficulty following dietary recommendations were financial difficulty (32%), time constraints (30%), not knowing what foods are best to eat (29%) and difficulty selecting appropriate foods when eating at restaurants (22%). Factors associated with difficulty following dietary recommendations were age, diabetes duration, smoking, insulin use, forgetting medications, own health rating, HbA_{1c} level, insufficient physical activity, glucose testing, diabetes distress and depression (univariable analysis all $P < 0.01$) (Table S1). Younger people were 1.75 (95% CI, 1.42–2.16, $P < 0.001$) times more likely to report difficulty following dietary recommendations compared with older people after adjustment for potential confounders (Table S1). Younger people were more likely to report difficulty following dietary recommendations due to financial difficulty [adjusted odds ratio (OR) 1.63, 95% CI, 1.15–2.31; $P = 0.006$] and time constraints (adjusted OR 2.08, 1.47–2.95; $P < 0.001$) when compared with older people. By contrast, younger people were not more likely to report difficulty selecting appropriate foods when eating outside their home (adjusted OR 1.36, 0.97–1.89; $P = 0.073$) or knowing what foods are best to eat (adjusted OR 0.80, 0.56–1.14; $P = 0.218$) when compared with older people (Fig. 1; Table S2).

Physical activity

Overall, 63% of participants reported insufficient physical activity, (64% and 61% for younger and older people respectively, $P = 0.247$). Factors associated with insufficient physical activity were female gender, diabetes duration, smoking, insulin use, own health rating, HbA_{1c} level, diabetes distress and depression (univariable analysis all $P < 0.030$). Younger people were not significantly more likely to report insufficient physical activity when compared with older people after adjustment for potential confounders (adjusted OR 0.89, 0.73-1.08, $P = 0.225$) (Fig. 1; Table S2).

Monitoring blood glucose levels

Overall, 67% of people reported monitoring blood glucose levels as recommended, 27% reported not monitoring and 6% were unsure of the recommendations for blood glucose monitoring. A greater proportion of younger people reported not monitoring blood glucose levels as recommended compared with older people (32% and 22% respectively, $P < 0.001$). Factors associated with monitoring blood glucose levels as recommended were age, smoking, insulin use, forgetting medications, own health rating, HbA_{1c}, insufficient physical activity, difficulty following recommended diet, diabetes distress, depression, treatment for depression, diabetes educator and dietician review (univariable analysis all $P < 0.024$). Younger people were 1.43 (95% CI, 1.14–1.78, $P = 0.002$) times more likely to not monitor blood glucose levels as recommended when compared with older people after adjustment for potential confounders (Fig. 1; Table S3).

Medication use

Overall, 28% of people reported forgetting medications (35% and 20% for younger and older people respectively, $P < 0.001$). Insulin use was reported by 58% of people overall, with no difference between younger and older groups (58% and 59% respectively, $P = 0.561$). Factors associated with forgetting medications were age, diabetes duration, smoking, difficulty following recommended diet, own health rating, HbA_{1c}, insufficient physical activity,

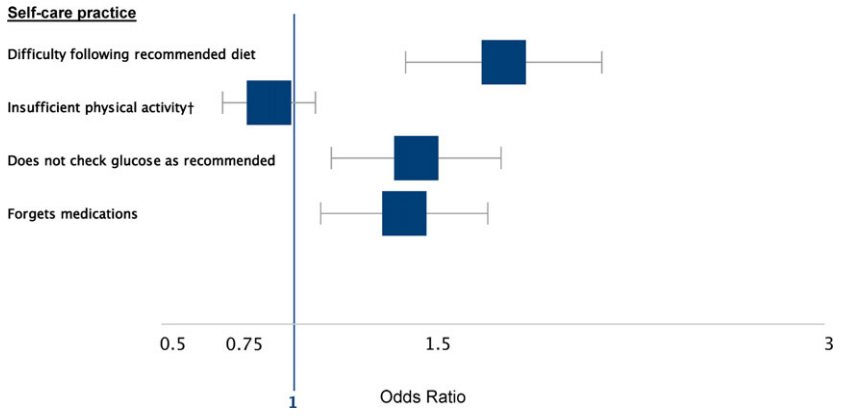

FIGURE 1 Adjusted odds of self-care factors by age group. *Odds ratios adjusted for age group, gender, smoking, insulin therapy, depression and health practitioner attendance. †HbA_{1c} 7% 53 mmol/mol. ‡Sufficient physical activity is defined as ≥150 total minutes per week (National Physical Activity Guidelines for Australians).

glucose testing, diabetes distress, depression and treatment for depression were associated with forgetting medications (univariable analysis all $P < 0.005$). Younger people were 1.38 (1.10–1.73, $P = 0.005$) times more likely to report forgetting medications compared with older people after adjustment for potential confounders (Fig. 1; Table S4). Younger people were more likely to report ceasing medications once they felt better (adjusted OR 0.63, 0.41–0.99; $P = 0.043$) than older people.

Use of complementary therapies was reported by 28% of people, with similar rates between the younger and older groups (27% vs. 28%, $P = 0.336$). Of people using complementary therapy, 15% had not informed their healthcare provider of these treatments.

Glycaemic control

Mean HbA_{1c} was 67.2 ± 2.7 mmol/mol (8.3 ± 1.9%) for the group overall [71.6 ± 1.6 mmol/mol (8.7 ± 2.0%) and 62.8 ± 6 mmol/mol (7.9 ± 1.6%) for younger and older people respectively, $P < 0.001$]. A smaller proportion of people in the younger age group had an $HbA_{1c} \leq 53$ mmol/mol (≤ 7.0%) than in the older age group (76% and 66%, $P < 0.001$) (Table 1). Factors associated with HbA_{1c} above target were age, diabetes duration, smoking, insulin use, forgetting medications, language difficulty, own health rating, insufficient physical activity, difficulty following recommended diet, glucose testing, depression and requirement for diabetes specialist review (univariable analysis all $P < 0.054$). Younger people were 1.60 (1.29–1.98, $P < 0.001$) times more likely to have an HbA_{1c} above target compared with older people after adjustment for potential confounders (Table S5).

The self-care practices associated with an $HbA_{1c} > 53$ mmol/mol (> 7.0%) were difficulty following dietary recommendations (adjusted OR 1.50, 1.20–1.88; $P = 0.001$), poor medication adherence (adjusted OR 1.30, 1.02–1.65; $P = 0.031$) and testing blood glucose as recommended (adjusted OR 0.62, 0.50–0.77; $P < 0.001$). Insufficient physical activity (adjusted OR 0.94, 0.76–1.15; $P = 0.529$) was not a significant determinant of HbA_{1c} above 53 mmol/mol (7.0%).

Longer diabetes duration was associated with HbA_{1c} levels above 53 mmol/mol (7.0%) but not with any of the self-care practices after adjustment for potential confounders (Table S3).

After the exclusion of people with diabetes duration of 2 years or less from the analysis, younger people remained more likely to report difficulty following dietary recommendations (adjusted OR 1.64, 1.30–2.06; $P < 0.001$), not monitoring blood glucose levels as recommended (adjusted OR 1.64, 1.29–2.08; $P < 0.001$), forgetting medications (adjusted OR 1.30, 1.01–1.65; $P = 0.038$) and having an $HbA_{1c} > 53$ mmol/mol (adjusted OR 1.63, 1.27–2.08; $P < 0.001$) than older people.

Discussion

In this large national cross-sectional study of people with Type 2 diabetes, we found that despite shorter diabetes duration, younger age was associated with worse glycaemic control and poorer diabetes self-care practices. Younger people were more likely to have difficulty following dietary recommendations, to be not monitoring glucose as recommended, to forget medications and to have HbA_{1c} levels > 53 mmol/mol (> 7.0%) compared with older people. The proportion of people engaging in sufficient physical activity were similar between the older and younger groups. These findings remained significant after adjustment for other relevant confounders and after exclusion of people with more recent diabetes onset (2 years), who may be relatively new to diabetes services and to not yet have had the opportunity to institute self-care practices or attain treatment targets.

Younger people may have more competing social, educational, travel, family or occupational commitments preventing them from engaging in self-care practices than older people with diabetes and may be more likely to face stigma and discrimination, given that Type 2 diabetes is widely perceived as a 'self-inflicted' lifestyle disease associated with older age [15]. Conversely, older people with Type 2 diabetes may receive more support from health professionals and family [15]. Younger people may also not perceive their condition to be serious and postpone lifestyle changes until diabetes-related complications appear, whereas older people may be more likely to institute self-care practices having already been diagnosed with diabetes complications [16]. Younger people with diabetes may benefit from the provision of targeted, age-appropriate options for healthy eating, physical activity, time and stress management. This group may also benefit from access to face to face or online peer support services.

The overall proportion of people in our study who were not following the self-care recommendations for diet, physical activity, medication adherence and glucose testing were similar to those reported by other studies [11]. Moreover, previous Australian [8,17] and international studies [12] have also found younger age is associated with poorer self-care practices, specifically less monitoring of blood glucose levels and medication adherence. Our data suggest that younger people with Type 2 diabetes may require more intensive or targeted self-care support than older people.

Diet adherence

A significant proportion of people reported difficulty adhering to the prescribed diet even though most had received advice from a dietitian within the past 12 months. The proportion of people reporting difficulty adhering to the prescribed diet in our study is higher than that reported in

Iran [13], similar to reports from the USA [18] and Taiwan [19], and lower than reported in Saudi Arabia [20] and Hungary [21]. Some studies report an association between younger age and decreased adherence to dietary recommendations [19] but others do not [20]. This may be due to ethnic or cultural variations because these studies were conducted at different times in different countries. Data from the Dutch and Australian Diabetes Management and Impact for Long-term Empowerment and Success (MILES) study also suggests that younger people with Type 2 diabetes are less likely to follow dietary recommendations compared with older people; however, the age cut-off used in that study (40 years of age) differed from our study and our population were treated at diabetes centres [12]. Like our study, others have also identified financial barriers as a common reason for difficulty adhering to prescribe diets. Unfortunately, there were not sufficient data to examine diet adherence by ethnicity or urbanization, previously identified as contributory factors to dietary adherence [22].

Most people did not engage in adequate physical activity, with no difference between older and younger groups. The benefits of sufficient activity are many, irrespective of age, including improved glycaemic control, mental health, insulin sensitivity, reduced obesity and cardiovascular disease risk. However, insulin and some other diabetes medications may increase the risk of hypoglycaemia when undertaking physical activity and the fear of hypoglycaemia may limit physical activity unless appropriate precautions are taken. The non-adherence rates to physical activity reported here (61–63%) were similar to those reported internationally [18]. However, it is difficult to directly compare absolute levels of physical activity, given that the definition of sufficient physical activity across these studies varied from 90 to 150 min/week. We considered 150 min of physical activity a week to be sufficient for health benefit as per the National Physical Activity Guidelines for Australians [11].

Monitoring blood glucose levels

Younger people were half as likely to monitor blood glucose levels as recommended compared with older people. In other studies, reported rates of monitoring of blood glucose are comparable with our data. Although monitoring blood glucose levels is essential for people treated with insulin, benefits for people not treated with insulin are less clear. A meta-analysis examining this in people with Type 2 diabetes who did not use of insulin, concluded that monitoring blood glucose levels has a small benefit on glycaemic control (which subsides after 12 months), but no effect on patient satisfaction, well-being or health-related quality of life [23]. This supports our finding that blood glucose monitoring was not related to peoples' subjective rating of their health care after adjustment for other confounding factors. In our study, glucose monitoring was associated with lower HbA_{1c} after adjustment for insulin use. Other studies have reported that monitoring blood glucose levels was associated with lower HbA_{1c} in people who have changed treatment, but not in those who did not change treatment [17]. Thus, monitoring blood glucose levels may yield the most benefit for people on insulin or those who require intensification of glucose lowering therapy. Older people may benefit from re-assessment of self-management knowledge and skills when regimen changes are made, or an individual's functional abilities diminish. Older people with cognitive or functional impairment may benefit from the provision of diabetes education to carers and family members.

Glycaemic control

Younger people were less likely to have $HbA_{1c} < 53$ mmol/mol (< 7.0%), as recommended for most people with Type 2 diabetes. Very frail, cognitively impaired or disabled older people may be less likely to seek care for diabetes compared with higher-functioning, community-dwelling older people with diabetes. Diabetes treatment targets should be individualized, taking into account the circumstances and wishes of the person with diabetes. Older people may be more likely to have comorbid conditions, cognitive or functional impairment or be at increased risk of hypoglycaemia secondary to diminished counter-regulatory responses thus making a higher HbA_{1c} ($\leq$ 64 mmol/mol; 8.0%) target more appropriate. The American Diabetes Association recommends that older people who are cognitively and functionally intact and have significant life expectancy should be treated with interventions and goals similar to younger people with diabetes [24]. A HbA_{1c} target of $\leq$42 mmol/mol (6.0%) may be appropriate for younger people with short diabetes duration and no clinical cardiovascular disease, as recommended by the Australian Diabetes Society [25]. This would mean that the underlying differences in glycaemic control between younger and older people may be underestimated here. Self-care practices, education of early recognition and treatment of hypoglycaemic symptoms, understanding how medications work as well as the impact of food and physical activity on glucose levels are important to prevent hypoglycaemia [25].

Medication use

Consistent with previous studies (where medication adherence ranges from 70% to 99%), we found that medication adherence was reasonably good, and associated with lower HbA_{1c} [23]. Previous data also suggest that psychological factors such as depression or diabetes distress play an important role in medication adherence [26]. We found both depression and diabetes distress to be independently associated with poor medication adherence. Interventions aimed at increasing psychological and social supports for people with diabetes have shown success in increasing medication adherence and reducing diabetes-related hospital admissions [27]. Financial difficulties have also been shown to be a

barrier to medication adherence [28]. However, these data are from nations with limited healthcare and welfare systems and may be less applicable in the Australian context due to universal healthcare and welfare policies.

Further research is required to understand the unique needs of younger people with Type 2 diabetes. Such research may inform specific supports for people with Type 2 diabetes, to increase engagement with self-care measures, improve diabetes control and thereby reduce short- and long-term complications. Younger people may particularly benefit from mobile and smartphone health technologies which have shown promise in improving diabetes care [29]. There is also evidence to suggest that highly structured diabetes self-care education intervention incorporating cognitive–behavioural strategies are more effective than standard group or individual education sessions for older people whereas individual education is more effective for younger people [30].

A strength of this analysis is the nationwide survey of diabetes centres with a large data set of people. We obtained information on many variables likely to impact on self-care practices. Limitations included that many of the people received care at tertiary diabetes centres and were therefore more likely to represent a specialist-treated group rather than a primary care-treated group. Referral bias is also possible as GPs may refer more challenging people as well as younger people who have more complex disease, are less adherent or require more stringent control of glycaemic and cardiovascular risk factors. Use of de-identified data precluded: (1) independent verification of diagnoses and treatments, nevertheless, previous data suggest ~ 90% of self-reported diabetes information to be accurate and questionnaires to be a very reliable way of gathering data regarding diabetes self-care practices [31]; (2) collection of additional information regarding financial, educational and cognitive status; or (3) longitudinal analyses to identify the directions of the reported relationships. Finally, our study population was predominantly Australian-born and English-speaking which may limit the generalizability of our findings, although not to a great extent given that diabetes self-care practices have not been shown to vary greatly by ethnicity [32].

Conclusions

Younger people with Type 2 diabetes attending diabetes centres demonstrate reduced adherence to diabetes self-care practices and poorer glycaemic control compared with older people. These findings emphasize the importance of addressing the self-care practices and providing strategies for people with Type 2 diabetes, with special focus on younger people. Younger people may benefit from more targeted, evidence-based, multidisciplinary initiatives to optimize self-care practices.

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Competing interests

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Author contributions

NN: study design, literature review, statistical analysis and interpretation, critical discussion, drafting and revision of the manuscript. AP: statistical analysis assistance and interpretation, critical discussion, revision of the manuscript. SR: statistical analysis and interpretation of the data, revision of the manuscript. NW: study conception and design, revision of the manuscript. SA: study conception and design, revision of the manuscript. BdC: study design, supervision of statistical analysis, critical discussion, critical revision of the manuscript, supervision of the project. SZ: study conception and design, design of analyses, critical revision of the manuscript, supervision of the project. NN, SR, and SZ had full access to the data and take responsibility for the integrity of the data and accuracy of the analysis. All authors have read and approved the final manuscript.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Difficultly following recommended diet.
Table S2. Insufficient physical activity.
Table S3. Does not monitor glucose as recommended.
Table S4. Forgets mediations.
Table S5. HbA1c above target.

Appendix

Table A1 Participating diabetes centres by state or territory

State/Territory	No of participating centres	No of patients
Australian Capital Territory	1	78
New South Wales	10	480
Queensland	10	699
South Australia	2	111
Tasmania	3	129
Victoria	22	969
Western Australia	2	86
Total	50	2552

Table A2 Unadjusted and adjusted odds of diabetes self-care practices by age

		Univariable analyses		Multivariable analyses*	
Self-care practice	Event rate	≤ 64 years†	*P*-value	≤ 64 years†	*P*-value
Difficulty following recommended diet	846/2211	2.29 (1.95–2.70)	<0.001	1.75 (1.42–2.16)	<0.001
Insufficient physical activity‡	1366/2213	0.91 (0.77–1.07)	0.247	0.89 (0.73–1.08)	0.225
Does not check glucose as recommended	715/2210	1.74 (1.45–2.08)	<0.001	1.43 (1.14–1.78)	0.002
Forgets medications	610/2211	2.11 (1.76–2.53)	<0.001	1.38 (1.10–1.73)	0.005

*Odds ratios adjusted for age group gender, smoking, insulin therapy, depression and health practitioner attendance.
†Compared with > 65 years.
‡Sufficient physical activity is defined as ≥ 150 total minutes per week (National Physical Activity Guidelines for Australians).

Table A3 Adjusted odds of diabetes self-care practices by age, excluding patients with diabetes duration ≤ 2 years

	Multivariable analyses* for all patients		Multivariable analyses* for patient with >2 years diabetes duration	
Self-care practice	≤ 64 years	*P*-value	≤ 64 years†	*P*-value
Difficulty following recommended diet	1.75 (1.42–2.16)	< 0.001	1.64 (1.30–2.06)	< 0.001
Insufficient physical activity‡	0.89 (0.73–1.08)	0.225	0.81 (0.65–1.00)	0.054
Does not monitor blood glucose levels as recommended	1.43 (1.14–1.78)	0.002	1.64 (1.29–2.08)	< 0.001
Forgets medications	1.38 (1.10–1.73)	0.005	1.30 (1.01–1.65)	0.038
HbA_{1c} > 7.0%	1.60 (1.29–1.98)	< 0.001	1.63 (1.27–2.08)	< 0.001

*Odds ratios adjusted for age group gender, smoking, insulin therapy, depression and health practitioner attendance.
†Compared with > 65 years.
‡Sufficient physical activity is defined as ≥150 total minutes per week (National Physical Activity Guidelines for Australians).