## Research

# Type 2 diabetes and physical activity: barriers and enablers to diabetes control in Eastern India

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## Abstract

*Introduction:* Type 2 diabetes (T2D) has tremendous morbidity burden owing to disease management and complication prevention. Behavior modification identified as a key to management includes healthy diet and regular physical activity (PA). This study aims to identify patterns and preferences of PA of T2D patients and explore perceived enablers and barriers for diabetes control in Bhubaneswar. *Methods:* Cross-sectional, facility-based study conducted in the private sector from June to August 2014 recruited 321 T2D patients using semi-structured questionnaires. Descriptive statistics and associations of PA were computed. *Results:* Almost two-thirds of patients (59%) were reported performing PA frequently. Majority patients cited walking as the most preferred mode of PA (79%) with 41% performing PA daily. Actual versus perceived weight was a complete mismatch with most patients misjudging their weight. Reasons for enabling PA included 'controlling diabetes' and 'doctor's advice' as key factors, while 'lack of time' and 'unwillingness' were main barriers among inactive patients. *Conclusion:* Counseling on PA by physicians during routine visits, along with tailored or patient-specific interventions should be considered. Focus on social support for positive behavioral changes and motivation play a central role in diabetes control.

## Introduction

A total of 442 million people worldwide live with diabetes, and type 2 diabetes (T2D) comprises 90% of the burden (Huffman and Vaccaro, 2012; World Health Organization, 2016). India is referred to as the 'Diabetes Capital of the World' since the International Diabetes Federation has stated that the number of diabetics is expected to rise from 40.9 million to 69.9 million by 2025 (Madaan *et al.*, 2014). Besides genetic predisposition to diabetes, studies have also shown strong linkage to four key behavioral risk factors, viz., tobacco consumption, physical inactivity, unhealthy diet, and increased use of alcohol (World Health Organization, 2016). Although the pandemic of physical inactivity causes 7% of the burden of disease from diabetes and is attributed to 9% of premature mortality (Lee *et al.*, 2012), the rising prevalence of diabetes largely driven by physical inactivity among other factors has become a major concern for healthcare in India (World Health Organization, 2014).

Physical activity (PA) not only contributes to prevention or delay in development of other long-term diabetes complications, such as neuropathy, retinopathy, and nephropathy, but also may slow the progression of existing complications (Thomas *et al.*, 2004). Additionally, it also includes positive impact on insulin action, glycemic control, and metabolic abnormalities associated with T2D (Paffenbarger *et al.*, 1993; Pate *et al.*, 1995; Hayes and Kriska, 2008). Thus based on clear evidences that PA is essential for the management of T2D (Pan *et al.*, 1997; Tuomilehto *et al.*, 2001; Knowler *et al.*, 2002), physicians treating diabetes patients generally advise uptake or increase in PA levels, consumption of a healthy diet, and, if needed, tablets and/or insulin to control blood glucose levels (Lawton *et al.*, 2006). Thus, for self-management beyond clinical treatment, the onus lies on the patient. However, studies have reported that individuals with diabetes engage in less PA than non-diabetics, live more sedentary lifestyles, and have poor metabolic control (Ford and Herman, 1995; Olivarius *et al.*, 2001; Nelson *et al.*, 2002). This perhaps can be attributed to various personal, environmental, psychosocial factors that may interfere with following exercise recommendations, thus making diabetes management difficult (Huffman and Vaccaro, 2012). The principles of Alma-Ata declaring 'Health for All' though not directly, but indeed signify major importance with context to control and management of diabetes as well (World Health Organization, 1978). Thus, our study aims to assess the pattern and proportion of PA among T2D patients, and the associated enablers and

barriers for management of diabetes in Eastern India. The identified enablers and barriers then in turn can be examined at patient, community, and perhaps even at policy-level for adopting changes for management of the diabetes pandemic.

## Methods

A cross-sectional, facility-based study with 341 T2D patients recruited from specialist clinics at a private hospital in Bhubaneswar, Odisha from June to August 2014 was conducted. The facility selection was done by purposive sampling due to high case load and study feasibility.

Using OpenEpi version 3, the minimum required sample size was calculated as 321 by means of the formula

$$n = [DEFF \times Np(1-p)] / \left[d^2 / Z^2_{1-\alpha/2} \times (N-1) + p \times (1-p)\right]$$

where $n$ = the required sample size; population size $(N)$ = 100,000; $p$ = hypothesized frequency – 25%; $d$ = confidence limits – 5%; DEFF = design effect – 1.

From the above formula the sample size selected was 289. Considering 10% non-response rate, the sample size calculated was 289/(1 – 0.1). Hence the sample size finalized was 321.

Face-to-face interviews were conducted using a semi-structured questionnaire whose domains included socio-demographic details as well as information related to diabetes, and pattern of PA. Each participant (patient) was included only once in the study during the study period, after obtaining verbal consent for participation.

Data entry and analysis was done with Statistical Package for the Social Sciences (SPSS) version 20, to obtain descriptive statistics. Categorical data were presented as frequency (%). $\chi^2$-test was used to identify the association between socio-demographic factors and pattern of PA.

The study was reviewed and approved by the Institutional Ethics Committee of Indian Institute of Public Health Bhubaneswar (IIPH-B). Patient anonymity was maintained through assigning of unique codes and data were kept confidential.

## Results

### Patient demographics and characteristics

As depicted in Table 1, among the 321 T2D patients interviewed, above 60% patients were between 35 and 60 years ($n$ = 196) with mean age of 51 years with 12.8 SD. Similarly, 64% ($n$ = 204/321) were males and proportion of graduates was the highest (44%), while 54% contributed to family income. Table 1 also shows 61% patients ($n$ = 195) consumed non-vegetarian food as their primary diet, while 8% reported smoking and 28% consuming smokeless tobacco; 55% patients admitted to family history of diabetes, while 69% patients reported spouse suffering from diabetes. Almost 70% of diabetes patients (69%, $n$ = 220) reported co-morbidities: hypertension, arthritis, gastritis, asthma, and cardiovascular diseases.

### Diet and PA

From the entire cohort of T2D patients, 45% ($n$ = 144/321) reported strict control of their diet, 44% patients reported controlling their diet moderately, while 11% did not practice any form of diet control.

Further almost 60% patients reported ($n$ = 190/321; 59%) performing PA frequently. These patients were categorized as

**Table 1.** Patient profile ($N$ = 321)

|  | n (%) |
|---|---|
| **Age (in years)** | |
| 20–34 | 44 (14) |
| 35–60 | 81 (25) |
| > 60 | 196 (61) |
| Mean (SD) | 51 (12.8 years) |
| **Gender** | |
| Male | 204 (64) |
| Female | 117 (36) |
| **Education** | |
| Uneducated | 9 (3) |
| Secondary and below | 93 (29) |
| Higher secondary | 18 (6) |
| Graduate | 140 (44) |
| Postgraduate and above | 61 (19) |
| **Income contribution** | |
| Housewife | 96 (30) |
| Contributing | 172 (54) |
| Not contributing | 46 (14) |
| Not available | 7 (2) |
| **Food habits** | |
| Vegetarian | 126 (39) |
| Non-vegetarian | 195 (61) |
| **Smoker** | |
| Yes | 27 (8) |
| No | 294 (92) |
| **Smokeless tobacco user** | |
| Yes | 91 (28) |
| No | 230 (72) |
| **Family history of diabetes** | |
| Yes | 176 (55) |
| No | 145 (45) |
| **Spouse history of diabetes** | |
| Yes | 55 (17) |
| No | 266 (83) |
| **Co-morbid conditions** | |
| Yes | 220 (69) |
| No | 101 (32) |

**Table 1.** (*Continued*)

| | n (%) |
|---|---|
| Type of co-morbid conditions[1] | |
| Hypertension | 162 |
| Arthritis | 48 |
| Gastritis | 46 |
| Asthma | 19 |
| Cardiovascular disease | 17 |

[1]Some patients reported more than one co-morbid condition

active and the remaining 41% were categorized as inactive since they reported of not performing any kind of PA. Gender differences showed that 62% males ($n = 127/204$) performed PA compared to 54% females ($n = 63/117$) (data not shown).

Regarding the forms of PA undertaken, as seen in Figure 1, almost 80%, that is, 150 (79%; $n = 150/190$) patients undertook walking – either morning or any time of the day, 7% reported cycling, 5% each reported gardening and yoga, four patients undertook outdoor sports, and two patients preferred jogging.

Of the 190 'active' patients, three-fourths stated that they started exercising after being diagnosed with diabetes ($n = 142/190$; 75%), while the remaining 25% reported that they were in the habit of exercising before their diabetes diagnosis ($n = 48$) (data not shown).

Further as seen in Table 2, more than 50% patients reported that they were exercising 2–3 times per week (51%; $n = 97/190$), while 41% patients were exercising daily, and <5% patients were exercising once a week or less. Duration of PA was variable between patients, with almost two-thirds of patients (59%, $n = 112$) performing PA for <30 min per session compared to almost similar number of patients that performed PA for more than 30 and 45 min, respectively.

### Perception regarding own weight

After patients were weighed, each patient was questioned to assume their weight category. Of the total 321 patients, a complete mismatch of individual perceived and actual weights was seen. As seen in Figure 2, though only four patients were underweight, 34 patients perceived themselves as being underweight. Similar observations were seen for normal weight patients (136 versus 206). While for the overweight and obese categories, fewer patients underestimated their actual weight categories (72 versus 136 and 9 versus 45).
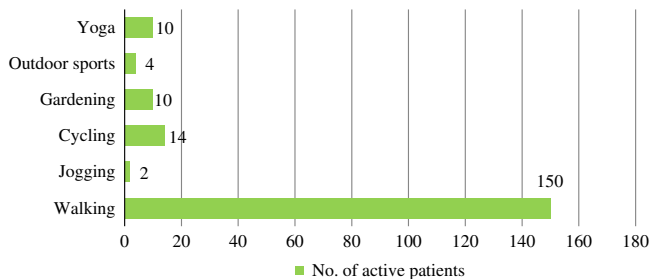


**Figure 1.** Frequently undertaken physical activities as reported by 190 type 2 diabetes patients. The figure depicts various types of physical activities undertaken by the 'active' patients in the cohort, with walking as the most preferred activity

**Table 2.** Frequency and duration of performing physical activities for diabetes management and control as reported by T2D patients ($N = 190$)

| | n (%) |
|---|---|
| Frequency of physical activity | |
| Once a week | 7 (4) |
| 2–3 times per week | 97 (51) |
| 4–5 times per week | 8 (4) |
| Daily | 78 (41) |
| Duration of physical activity | |
| < 30 min | 112 (59) |
| 30–45 min | 37 (19) |
| > 45 min | 41 (22) |

### Barriers and enablers to PA

Barriers and enablers, that is, reasons for not performing or performing PA were captured during the study. These reasons were divided into personal or *internal* reasons that could be controlled or dependent on the patients (Korkiakangas, Alahuhta and Laitinen, 2009), while *external* reasons were related to infrastructure, weather, and so on, or independent (Serour *et al.*, 2007). Our study documented both personal and external reasons contributed to enabling patients to perform PAs (Table 3).

The key personal reasons for barriers of not performing PA included unwillingness by patients, laziness, illness, and tiredness/discomfort. Among the four patients that cited their age as a barrier for PA – all were above 70 years. Only two patients '*felt fit*', but did not perform any PA. The most common external barriers included lack of time or workload and other engagements in majority of the patients. Five patients cited lack of safe road and place to exercise as well, as seen in Table 3.

Personal enablers included control of diabetes, '*to feel good*' and stay active, while external enablers included doctors' advice and company for exercise featured as prominent enablers. Patients also stated other important reasons for exercising such as controlling other illnesses, including hypertension and joint pain, along with weight management.
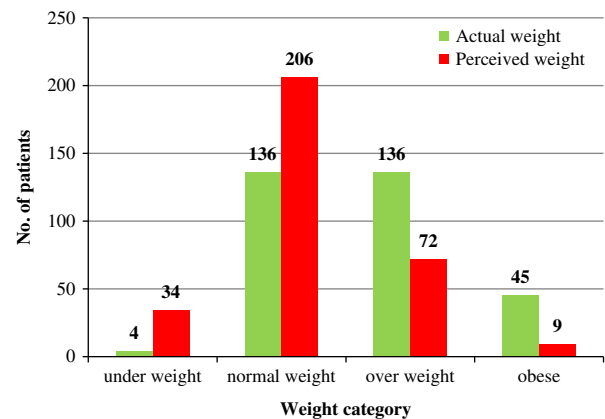


**Figure 2.** Distribution of perceived and actual weight of the 321 type 2 diabetes patients. The figure represents the mismatch of 'perceived' versus 'actual' weight of the entire cohort. The assumption of weight category by each patient was done prior to measuring individual weight

**Table 3.** Reasons for performing physical activity, viz., barriers and enablers

| Barriers[1] | N = 131 |
|---|---|
| *Personal* | |
| Age | 4 |
| Work at home | 24 |
| Unwillingness | 67 |
| 'Feel fit' | 2 |
| Laziness | 30 |
| Shy | 6 |
| Tired/discomfort | 31 |
| Illness including joint pain and pregnancy | 34 |
| Weakness | 21 |
| Fear of injury | 1 |
| *External* | |
| Climate | 2 |
| Lack of time/workload/other engagements | 82 |
| Lack of road safety and place for exercise | 5 |
| No company | 4 |
| No knowledge of type of exercise | 1 |
| Enablers[1] | N = 190 |
| *Personal* | |
| Diabetes control | 90 |
| Blood pressure control | 14 |
| Reduce joint pain | 10 |
| Weight management | 25 |
| 'Feel good' | 65 |
| Stay active/fitness | 59 |
| Increase appetite | 23 |
| 'Get good sleep' | 5 |
| *External* | |
| Doctor's advice | 55 |
| Family insisted | 10 |
| Friend's suggestion | 4 |
| Company for exercise | 14 |
| Dog walking | 1 |

[1]Some patients may have given more than one reason as an enabler or barrier

## Discussion

Our study describes the pattern of PA by T2D patients, and the enablers and barriers that influence their practice and preferences. The study conducted in the private sector of Eastern India adds value to the relative dearth of published data on the topic and the region. Since PA plays an integral part in diabetes management (American Diabetes Association, 2004), findings from the study related to PA by T2D patients are in concordance to the recent studies in India and globally (Qiu *et al.*, 2012; Anjana *et al.*, 2014).

Personal or internal barriers for self-management of diabetes as stated by patients are among the common reasons as seen in previous studies. These include lack of time, laziness, weakness (Mier *et al.*, 2007; Korkiakangas *et al.*, 2009; Bryant *et al.*, 2010; Miller and Marolen, 2012; Murray *et al.*, 2012; Qiu *et al.*, 2012). These internal barriers are individuals choices and attitude that need to be identified in order to change. Thus interventions must be planned in order for patients to first assess their areas and readiness to change, and then accordingly motivate the patient based on their acceptance of the disease and their intention to change (Fort *et al.*, 2013). Furthermore, our study highlighted important enablers such as social support by means of family and friend's suggestions along with company for exercise, which plays an important role in self-management of diabetes. The presence of social support in the form of emotional encouragement can also help overcome laziness, tiredness, and so on, which in turn can be improved by PA. These support systems have shown to improve diabetes control, knowledge, and psychosocial functioning (Van Dam *et al.*, 2005), similar to multiple sclerosis and rheumatoid arthritis patients (Aghaei *et al.*, 2016; Xu *et al.*, 2017).

Higher number of males were 'active' than females, with no association between gender and PA uptake. A total of 27 female patients stated that '*they had enough work at home and felt was comparable to physical activity*', hence did not perform any additional PA. Similar gender-based barriers have also been reported in other studies (Lawton *et al.*, 2006; Mier, Medina and Ory, 2007; Bryant *et al.*, 2010).

The findings of our study showed enabling factors that motivated patients to participate in regular PA, which included 'doctor's advice' as cited by 55 patients, while one patient complained lack of knowledge of exercise as a barrier. These findings further strengthen the need for counseling by treating physicians during routine visits that perhaps could also be tailored according to patients' requirements (Nelson *et al.*, 2002; Van Dam *et al.*, 2005; Haskell *et al.*, 2007). The harnessing of physicians to facilitate counseling recommends an imperative need for engagement of private sector providers as well as strengthening capacity of physicians across sectors.

In concordance to the principles of the Alma-Ata declaration, at primary care level for early control of a lifestyle disorder such as diabetes, adopting strategies that include inter-sectoral collaboration (of providers) and community engagement are highly recommended. Thus for achieving Health for All, use of patient-centered models for diabetes care such as the modified $3 \times 3P$ rubric (Bryant *et al.*, 2010) along with encouragement for weight monitoring and control by use of wearable technology (Chiauzzi, Rodarte and DasMahapatra, 2015) needs to be considered, especially for a developing country like India.

# References

Aghaei N, Karbandi S, Gorji M, Golkhatmi M and Alizadeh B (2016) Social support in relation to fatigue symptoms among patients with multiple sclerosis. *Indian Journal of Palliative Care* 22, 163–167.

American Diabetes Association (2004) Physical activity/exercise and diabetes. *Diabetes Care* 27, (Suppl 1) S58–S62.

Anjana RM, Pradeepa R, Das AK, Mohan D, Bhansali A, Joshi SR, Joshi PP, Dhandhania VK, Rao PV, Sudha V, Subhashini R, Unnikrishnan R, Madhu SV, Kaur T, Mohan V and Shukla DK (2014) Physical activity and inactivity patterns in India – results from the ICMR-INDIAB study (Phase-1) [ICMR-INDIAB-5]. *The International Journal of Behavioral Nutrition and Physical Activity* 11, 26.

Bryant LL, Chin NP, Cottrell LA, Duckles JM, Fernandez ID, Garces DM, Keyserling TC, McMilin CR, Peters KE, Samuel-Hodge CD, Tu S-P, Vu MB and Fitzpatrick AL (2010) Perceptions of cardiovascular health in underserved communities. *Preventing Chronic Disease* 7, A30.

Chiauzzi E, Rodarte C and DasMahapatra P (2015) Patient-centered activity monitoring in the self-management of chronic health conditions. *BMC Medicine* 13, 77.

Ford ES and Herman WH (1995) Leisure-time physical activity patterns in the U.S. diabetic population. Findings from the 1990 National Health Interview Survey – Health Promotion and Disease Prevention Supplement. *Diabetes Care* 18, 27–33.

Fort MP, Alvarado-Molina N, Pena L, Mendoza Montano C, Murrillo S and Martinez H (2013) Barriers and facilitating factors for disease self-management: a qualitative analysis of perceptions of patients receiving care for type 2 diabetes and/or hypertension in San José, Costa Rica and Tuxtla Gutiérrez, Mexico. *BMC Family Practice* 14, 131.

Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD and Bauman A (2007) Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise* 39, 1423–1434.

Hayes C and Kriska A (2008) Role of physical activity in diabetes management and prevention. *Journal of the American Dietetic Association* 108, (Suppl 4), 19–23.

Huffman FG and Vaccaro JA (2012) Physical activity, type 2 diabetes, and ethnicity: recent findings and implications. *American Journal of Lifestyle Medicine* 7, 104–114.

Knowler WC, Barrett-Connor E, Foweler SE, Hamman RF, Lachin JM, Walke EA and Nathan DM (2002) Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *New England Journal of Medicine* 346, 393–403.

Korkiakangas EE, Alahuhta MA and Laitinen JH (2009) Barriers to regular exercise among adults at high risk or diagnosed with type 2 diabetes: a systematic review. *Health Promotion International* 24, 416–427.

Lawton J, Ahmad N, Hanna L, Douglas M and Hallowell N (2006) "I can't do any serious exercise": barriers to physical activity amongst people of Pakistani and Indian origin with type 2 diabetes. *Health Education Research* 21, 43–54.

Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN and Katzmarzyk PT (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet* 380, 219–229.

Madaan H, Agrawal P, Garg R, Sachdeva A, Patra SK and Nair R (2014) Prevalence of diabetes mellitus in rural population of district Sonepat, India. *International Journal of Medical Science and Public Health* 3, 261–264.

Mier N, Medina AA and Ory MG (2007) Mexican Americans with type 2 diabetes: perspectives on definitions, motivators, and programs of physical activity. *Preventing Chronic Disease* 4, A24.

Miller ST and Marolen K (2012) Physical activity-related experiences, counseling expectations, personal responsibility, and altruism among urban African American women with type 2 diabetes. *The Diabetes Educator* 38, 229–235.

Murray CJ, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C, Ezzati M, Shibuya K, Salomon JA, Abdalla S, Aboyans V, Abraham J, Ackerman I, Aggarwal R, Ahn SY, Ali MK, Alvarado M, Anderson HR, Anderson LM, Andrews KG, Atkinson C, Baddour LM, Bahalim AN, Barker-Collo S, Barrero LH, Bartels DH, Basáñez MG, Baxter A, Bell ML, Benjamin EJ, Bennett D, Bernabé E, Bhalla K, Bhandari B, Bikbov B, Bin Abdulhak A, Birbeck G, Black JA, Blencowe H, Blore JD, Blyth F, Bolliger I, Bonaventure A, Boufous S, Bourne R, Boussinesq M, Braithwaite T, Brayne C, Bridgett L, Brooker S, Brooks P, Brugha TS, Bryan-Hancock C, Bucello C, Buchbinder R, Buckle G, Budke CM, Burch M, Burney P, Burstein R, Calabria B, Campbell B, Canter CE, Carabin H, Carapetis J, Carmona L, Cella C, Charlson F, Chen H, Cheng AT, Chou D, Chugh SS, Coffeng LE, Colan SD, Colquhoun S, Colson KE, Condon J, Connor MD, Cooper LT, Corriere M, Cortinovis M, de Vaccaro KC, Couser W, Cowie BC, Criqui MH, Cross M, Dabhadkar KC, Dahiya M, Dahodwala N, Damsere-Derry J, Danaei G, Davis A, De Leo D, Degenhardt L, Dellavalle R, Delossantos A, Denenberg J, Derrett S, Des Jarlais DC, Dharmaratne SD, Dherani M, Diaz-Torne C, Dolk H, Dorsey ER, Driscoll T, Duber H, Ebel B, Edmond K, Elbaz A, Ali SE, Erskine H, Erwin PJ, Espindola P, Ewoigbokhan SE, Farzadfar F, Feigin V, Felson DT, Ferrari A, Ferri CP, Fèvre EM, Finucane MM, Flaxman S, Flood L, Foreman K, Forouzanfar MH, Fowkes FG, Fransen M, Freeman MK, Gabbe BJ, Gabriel SE, Gakidou E, Ganatra HA, Garcia B, Gaspari F, Gillum RF, Gmel G, Gonzalez-Medina D, Gosselin R, Grainger R, Grant B, Groeger J, Guillemin F, Gunnell D, Gupta R, Haagsma J, Hagan H, Halasa YA, Hall W, Haring D, Haro JM, Harrison JE, Havmoeller R, Hay RJ, Higashi H, Hill C, Hoen B, Hoffman H, Hotez PJ, Hoy D, Huang JJ, Ibeanusi SE, Jacobsen KH, James SL, Jarvis D, Jasrasaria R, Jayaraman S, Johns N, Jonas JB, Karthikeyan G, Kassebaum N, Kawakami N, Keren A, Khoo JP, King CH, Knowlton LM, Kobusingye O, Koranteng A, Krishnamurthi R, Laden F, Lalloo R, Laslett LL, Lathlean T, Leasher JL, Lee YY, Leigh J, Levinson D, Lim SS, Limb E, Lin JK, Lipnick M, Lipshultz SE, Liu W, Loane M, Ohno SL, Lyons R, Mabweijano J, MacIntyre MF, Malekzadeh R, Mallinger L, Manivannan S, Marcenes W, March L, Margolis DJ, Marks GB, Marks R, Matsumori A, Matzopoulos R, Mayosi BM, McAnulty JH, McDermott MM, McGill N, McGrath J, Medina-Mora ME, Meltzer M, Mensah GA, Merriman TR, Meyer AC, Miglioli V, Miller M, Miller TR, Mitchell PB, Mock C, Mocumbi AO, Moffitt TE, Mokdad AA, Monasta L, Montico M, Moradi-Lakeh M, Moran A, Morawska L, Mori R, Murdoch ME, Mwaniki MK, Naidoo K, Nair MN, Naldi L, Narayan KM, Nelson PK, Nelson RG, Nevitt MC, Newton CR, Nolte S, Norman P, Norman RO, Donnell MO, Hanlon S, Olives C, Omer SB, Ortblad K, Osborne R, Ozgediz D, Page A, Pahari B, Pandian JD, Rivero AP, Patten SB, Pearce N, Padilla RP, Perez-Ruiz F, Perico N, Pesudovs K, Phillips D, Phillips MR, Pierce K, Pion S, Polanczyk GV, Polinder S, Pope CA 3rd, Popova S, Porrini E, Pourmalek F, Prince M, Pullan RL, Ramaiah KD, Ranganathan D, Razavi H, Regan M, Rehm JT, Rein DB, Remuzzi G, Richardson K, Rivara FP, Roberts T, Robinson C, De Leòn FR, Ronfani L, Room R, Rosenfeld LC, Rushton L, Sacco RL, Saha S, Sampson U, Sanchez-Riera L, Sanman E, Schwebel DC, Scott JG, Segui-Gomez M, Shahraz S, Shepard DS, Shin H, Shivakoti R, Singh D, Singh GM, Singh JA, Singleton J, Sleet DA, Sliwa K, Smith E, Smith JL, Stapelberg NJ, Steer A, Steiner T, Stolk WA, Stovner LJ, Sudfeld C, Syed S, Tamburlini G, Tavakkoli M, Taylor HR, Taylor JA, Taylor WJ, Thomas B, Thomson WM, Thurston GD, Tleyjeh IM, Tonelli M, Towbin JA, Truelsen T, Tsilimbaris MK, Ubeda C, Undurraga EA, van der Werf MJ, van Os J, Vavilala MS, Venketasubramanian N, Wang M, Wang W, Watt K, Weatherall DJ, Weinstock MA, Weintraub R, Weisskopf MG, Weissman MM, White RA, Whiteford H, Wiebe N, Wiersma ST, Wilkinson JD, Williams HC, Williams SR, Witt E, Wolfe F, Woolf AD, Wulf S, Yeh PH, Zaidi AK, Zheng ZJ, Zonies D, Lopez AD, AlMazroa MA and Memish ZA (2012) Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet* 380, 2197–2223.

Nelson KM, Reiber G and Boyko EJ (2002) Diet and exercise among adults with type 2 diabetes: findings from the third national health and nutrition examination survey (NHANES III). *Diabetes Care* 25, 1722–1728.

**Olivarius NF, Beck-Nielsen H, Andreasen AH, Horder M and Pedersen PA** (2001) Randomised controlled trial of structured personal care of type 2 diabetes mellitus. *BMJ* **323**, 970–975.

**Paffenbarger RS, Hyde RT, Wing AL, Lee IM, Jung DL and Kampert JB** (1993) The association of changes in physical-activity level and other lifestyle characteristics with mortality among men. *New England Journal of Medicine* **328**, 538–545.

**Pan XR, Li GW, Hu YH, Wang JX, Yang WY, An ZX, Hu ZX, Lin J, Xiao JZ, Cao HB, Liu PA, Jiang XG, Jiang YY, Wang JP, Zheng H, Zhang H, Bennett PH and Howard BV** (1997) Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance: The Da Qing IGT and diabetes study. *Diabetes Care* **20**, 537–544.

**Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC, Kriska A, Leon AS, Marcus BH, Morris J, Paffenbarger RS, Patrick K, Pollock ML, Rippe JM, Sallis J and Wilmore JH** (1995) Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* **273**, 402–7.

**Qiu S, Sun Z, Cai X, Liu L and Yang B** (2012) Improving patients' adherence to physical activity in diabetes mellitus: a review. *Diabetes and Metabolism Journal* **36**, 1–5.

**Serour M, Alqhenaei H, Al-Saqabi S, Mustafa AR and Ben-Nakhi A** (2007) Cultural factors and patients' adherence to lifestyle measures. *The British Journal of General Practice: The journal of the Royal College of General Practitioners* **57**, 291–295.

**Thomas N, Alder E and Leese GP** (2004) Barriers to physical activity in patients with diabetes. *Postgraduate Medical Journal* **80**, 287–291.

**Tuomilehto J, Lindstrom J, Eriksson JG, Valle TT, Hamalainen H, Illane-Parikka P, Keinänen-Kiukaanniemi S, Laakso M, Louheranta A, Rastas M, Salminen V, Uusitupa M and Finnish Diabetes Prevention Study Group** (2001) Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of Medicine* **344**, 1343–1350.

**Van Dam HA, Van Der Horst FG, Knoops L, Ryckman RM, Crebolder HF and Van Der Borne BH** (2005) Social support in diabetes: a systematic review of controlled intervention studies. *Patient Education and Counseling* **59**, 1–12.

**World Health Organization** (1978) Declaration of Alma-Ata. *International Conference on Primary Health Care, Alma-Ata, USSR, 6–12 September 1978.* https://doi.org/doi: 10.1016/S0140-6736(79)90622-6.

**World Health Organization** (2014) Global status report on non-communicable diseases: attaining the nine global non-communicable diseases targets – a shared responsibility. Retrieved from http://apps.who.int/iris/bitstream/handle/10665/148114/9789241564854_eng.pdf?sequence=1.

**World Health Organization** (2016) Global report on diabetes. Retrieved from http://www.who.int/about/licensing/.

**Xu N, Zhao S, Xue H, Fu W, Liu L, Zhang T, Huang R and Zhang N** (2017) Associations of perceived social support and positive psychological resources with fatigue symptom in patients with rheumatoid arthritis. *PLoS One* **12**, e0173293.