

## REVIEW

# Education and Self-Management for Women with Polycystic Ovary Syndrome; a Narrative Review of Literature

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## Abstract

Polycystic ovary syndrome (PCOS) is the most common endocrine condition in women of reproductive age and is associated with high risk of long term metabolic and psychological conditions such as diabetes, cardiovascular disease and depression. These patients present at a young age to the health care system and seek information about their condition. A structured education program seems to be able to answer these questions. Structured education self-management programs are pragmatic and cost-effective patient-centered group educations which are underpinned by learning theories and empower patients to take control of their management and reduce their associated long term risks. In this paper, we introduce structured education programs and review the evidence of education programs for women with PCOS.

**Key Words:** Self-management, Structured education, Polycystic ovary syndrome.

## Background

Polycystic ovary syndrome (PCOS) is one of the most common endocrine abnormalities in women with a reported prevalence of up to 18% depending on the diagnostic criteria used (1-3). Over years the diagnosis and description of PCOS have changed. The first descriptions of PCOS were made around 2,500 years ago by Hippocrates in his notes on the “diseases of women” where he described “young women who do not become fertile despite having menstruation” and also attributed “general ill health” to the women who did not have any menstruation at all (4). “Ibn-Sina” (980 – 1037 A.D.) described a group of women with amenorrhea who have “masculine features and are generally obese” (5). In the nineteenth century, Rokitanski gave a detailed description of the anatomical and morphological changes which happened in an ovary affected by multiple cysts and described it as an “anomaly of texture”(6). It was not until Stein and Leventhal combined their findings of abnormal

ovarian morphology with hirsutism and amenorrhea to describe the syndrome in 1935 (7). PCOS is now diagnosed based on the presence of two out of three major criteria (8,9); A) Clinical or biochemical hyperandrogenism; B) Anovulation (chronic or oligo) which is defined as having less than 10 menstruation in a year (> 35 days intervals between menstruations) or evidence of the lack of ovulation despite regular menstruation. C) Polycystic ovaries on ultrasound. Table 1 summarizes the 4 possible phenotypes of PCOS based on the latest Rotterdam criteria (8).

Women with PCOS are often young (8,10) and emotionally distressed by their condition (11). The diagnosis of PCOS has a major impact on a woman's life; they have higher risk of impaired glucose regulation or pre-diabetes, type 2 diabetes mellitus (T2DM), obesity, metabolic syndrome, fatty liver disease, hypertension, dyslipidemia, cardiovascular diseases, sleep apnea, gestational problems, as well as depression (8-20). It is therefore a chronic condition with long lasting effects on women's life and therefore to reduce their long term cardiovascular and diabetes risk and improve their quality of life, a patient education and empowerment should also be a priority for these patients as it is for other chronic conditions such as diabetes (21,22). An essential part of this empowerment is increasing patient understanding of their condition through education program (23,24) and there is a growing body of evidence showing the effectiveness of such program in lifestyle change and improving the cardiovascular risk (25-27)

In this article we introduce structured education program and review the evidence of education program for women with PCOS.

## Methods

This is a narrative review, after conducting a search on PubMed and EMBASE for articles related to "patient education" AND "Polycystic Ovary syndrome" up to Oct 2013. A Rich Site Summary (RSS Filter) was subsequently set up on PubMed for any article related to PCOS.

## What are structured self-management interventions?

Self-management interventions are complex interventions that are designed to empower individuals who suffer from long-term conditions. Their aim is to motivate and increase confidence in those individuals with or at risk of a long-term condition to allow them to effectively carry out the daily decisions required to manage their condition and/or to make necessary lifestyle changes (28). In the UK, successful self-management interventions are well established in diabetes care with robustly evaluated national program such as Dose Adjustment for Normal Eating (DAFNE) [<http://www.dafne.uk.com/>] for patients with type 1 diabetes and Diabetes Education and Self-Management for Ongoing and Newly Diagnosed (DESMOND) [<http://www.desmond-project.org.uk/>] for those with type 2 diabetes. These programs fulfil the standard criteria set out by the Patient Education Working Group (24); as being evidence-based, with a structured written curriculum, trained educators, quality assured, and audited. Figure 1 shows the principle elements of DESMOND education program. Although these criteria are set out for diabetes education programs, they can be applied to any long-term condition.

The literature shows that patients with chronic conditions express a need for education and generally feel better when they understand their condition (29,30). It is well known

**Table 1.** Four Possible phenotypes of PCOS

Features	A	B	D	E
Hyperandrogenism	+	+	+	-
Oligo-anovulation	+	+	-	+
Polycystic Ovaries	+	-	+	+
Rotterdam Criteria (8)	√	√	√	√
√ Diagnosed with the criteria.				



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**Figure 1.** An illustration of the “diabetes education and self-management for ongoing and newly diagnosed (DESMOND)” program: an intervention model developed in Leicester Diabetes Centre programs (ref 62). Reproduced with permission.

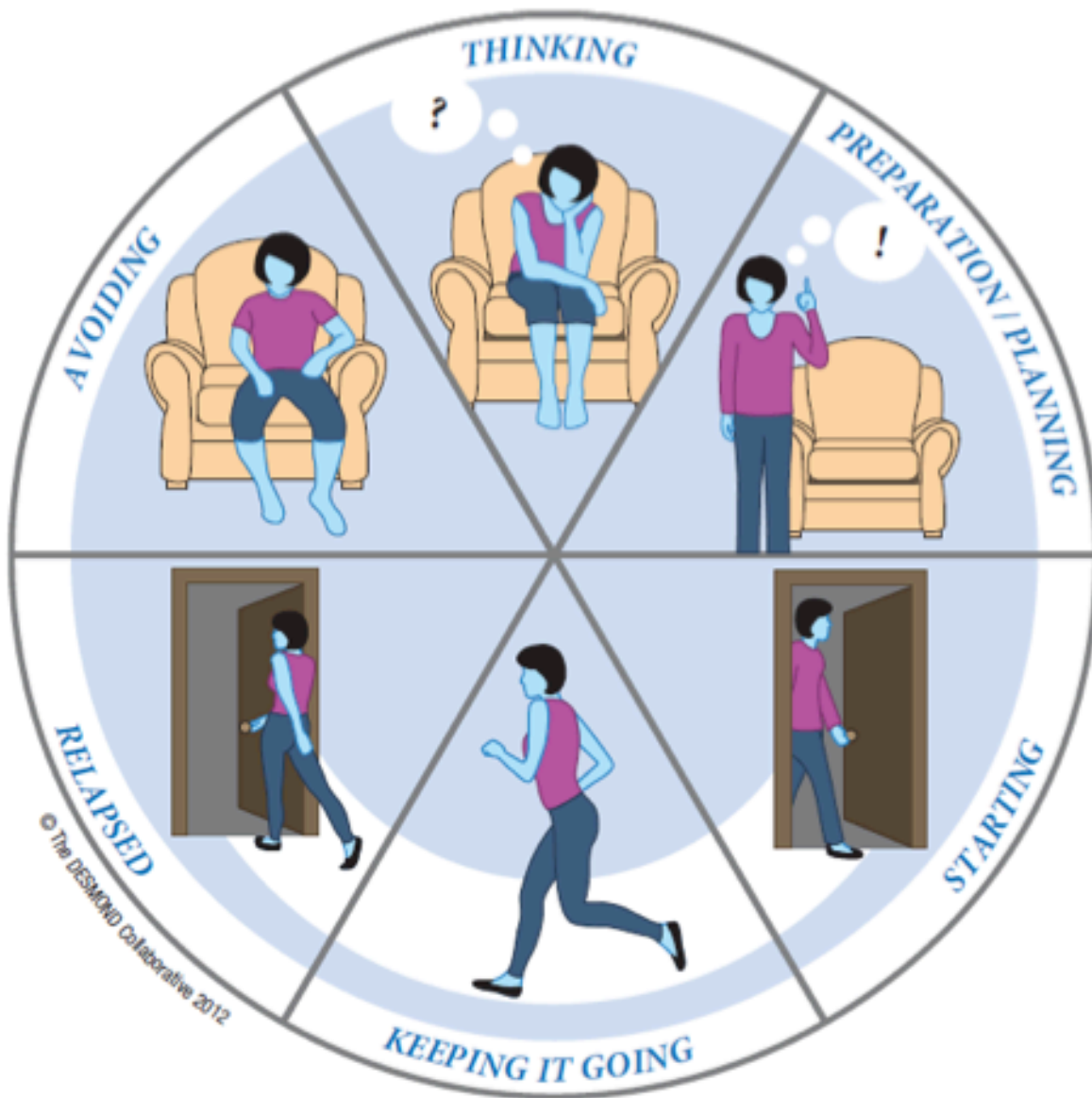
that any patients with a chronic condition seeks information about their condition to understand the five dimensions of the illness: timeline, consequences, cure/control, identity, and cause (31,32). Structured education programs explore these 5 dimensions and use different learning theories in patient-educator interaction to eventually increase patients understanding of their condition and offer self-management strategies for cure/control and lifestyle change (33). Figure 2 shows an example of a model used in DESMOND education programs.

### What do women with PCOS want and what is available for them?

Women with PCOS feel that they are “not being taken seriously” (34), they feel there is lack of communication with health care systems (34,35) and their emotional and psychosocial needs are not met (35,36). Some of the major themes encompassing women’s lived experience of managing PCOS are “frustration”, “confusion”, “searching”, and wanting to “gain control”(35,37,38). Lack of information has been shown to be associated with the poor health related quality of life (HRQoL) in this group

(30). One study showed that women with PCOS are more anxious than the age-matched non-PCOS women about their infertility, obesity, and long term health risks such as diabetes even at a young age group of 18-25 (39). This is also true for the teenagers who are keen to know more about the nature of the condition and emotional and physical aspects of PCOS (34). Providing information improves the quality of life in women with PCOS (40) and education about their condition improves their understanding of causes and treatment choices (41).

They would like to get information about the condition from their doctor (38,42) although this does not happen in majority of the patients (34,35,42), and leaves them with “frustration” (35). Patients eventually refer to the internet as their main source of information (42). The variety of on-line forums/chat rooms and websites is possibly an indication of these patients’ need to explore and find information. Websites like; “NHS choice”, “SoulCysters”, “Daily Strength”, “Verity website/ (facebook page)” and many more are full of questions asked by patients and trends of conversations about different PCOS related



**Figure 2.** The “cycle of change” used in DESMOND education programs (from ref 66).

signs, symptoms, treatments and complications. However, the information on the internet is not necessarily clear and concise, and users may need to refer to multiple sites to find their answers (43). Another problem with the internet is the lack of direct interaction with others and the level of peer support. Women with PCOS seek to have the support and look positively at peer support groups (44).

Increasing knowledge, understanding the underlying condition and interaction with peers are the main elements of a group based structured education program. There is, however, a lack of evidence for “structured education program” for women with PCOS. In a clinical research study aimed at investigating the ultrasound morphology of ovaries the participants (n=68) received education

about PCOS from the researcher (gynecologist) during the research visit (41). In the post-study internet survey these women indicated that direct education about physiology, underlying pathology and treatment choices and their mechanisms of actions in PCOS had been very helpful. Almost a third of these patients did not know that PCOS could present with a variety of signs and symptoms and found the advice from a health care professional (the doctor) helpful regarding the lifestyle changes (41). In research studies, information has been usually provided during a lifestyle intervention about the specific lifestyle change such as dietary (45-48) or physical activity (49) or both (50-53). Although there are some beneficial effects of lifestyle interventions on weight, waist circumference and insulin indices as evidenced by systematic reviews (54,55), but they hardly talk about patient education. There are few mentions of group interactions (51) or individual psychological input (56), and only in one study (57) the dietician reviews PCOS for participants as a disease and the benefits of diet on their risk factors (with no details provided) in an individual visit with participants. Clearly there is a gap in evidence and service provision of structured education for women with PCOS.

### **What can be offered?**

Women with PCOS suffer from a chronic condition, which puts them at high risk of diabetes and cardiovascular disease. In an extremely conservative estimation towards a lower estimation the reported overall cost of PCOS in the USA was around \$4.37 billion in 2004(58). The breakdown of the cost of PCOS was 2.1% for initial evaluation, 40.5% for PCOS-associated diabetes and the rest for treating menstrual dysfunction/abnormal uterine bleeding, infertility, and hirsutism.(58) Given that up to 69% of patients with PCOS never seek any medical advice for their symptoms (1,10) and therefore have no recorded history in the health care system, and the fact that mental health problems related to PCOS have not been incorporated into this cost analysis, the socio-economic impact of PCOS is likely to be significantly higher than the figures presented in the above study.

It therefore seems logical to think of interventions which can reduce long term health risks associated with the condition and improve patients' quality of life. Prevention of diabetes and cardiovascular diseases are highly recommended in the health system (26,27) and evidence shows that introduction of lifestyle interventions in the population at risk of diabetes is the most cost-effective approach in prevention of diabetes

(26,59,60). Patient centered education programs, which have been successful in increasing walking steps (61) or weight reduction (62) and illness perception even three years after a single 6 hours education program (63) have proved to be extremely cost effective (64) and therefore, pragmatic to implement in the health system (65). A similar model can be used to develop tailored structured education program for women with PCOS. Currently there are some studies on-going which are exploring this approach such as "structured education program to reduce Cardiovascular risk in women with Polycystic ovary syndrome (SUCCESS study) which is a randomized controlled trial aiming at testing such program NCT01462864.

### **Conclusion**

Polycystic ovary syndrome is a common chronic condition and is associated with high risk of long term metabolic and mental health conditions such as diabetes, cardiovascular disease and depression. Women with PCOS present at a young age to health system and seek information about their condition. Structured education programs may be able to answer these questions and empower patients to take control of the associated long term risks but more research in this field is required.

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### **Conflict of Interest**

None related to the presented work. KK and MJD are advisors to the Department of Health NHS Health Checks program and are members (KK Chair) of the NICE Program Development Group (PDG) on 'Preventing T2DM: risk identifications and interventions for individuals at high risk'

### **References**

1. March WA, Moore VM, Willson KJ, Phillips DI, Norman RJ, Davies MJ. The prevalence of polycystic ovary syndrome in a community sample assessed under

- contrasting diagnostic criteria. *Hum Reprod* 2010 Feb;25(2):544-51.
2. Knochenhauer ES, Key TJ, Kahsar-Miller M, Waggoner W, Boots LR, Azziz R. Prevalence of the polycystic ovary syndrome in unselected black and white women of the southeastern United States: a prospective study. *J Clin Endocrinol Metab* 1998 Sep;83(9):3078-82.
  3. Azziz R, Woods KS, Reyna R, Key TJ, Knochenhauer ES, Yildiz BO. The prevalence and features of the polycystic ovary syndrome in an unselected population. *J Clin Endocrinol Metab* 2004 Jun;89(6):2745-9.
  4. Hanson AE. Hippocrates: Diseases of Women 1. Signs: *Journal of Women in Culture and Society* 1975;1(2):567-84.
  5. Avicenna. The diseases of uterus. In: Abd ul-Rahman Sharaf-Kandi (Persian Translator), editor. *The Canon of Medicine Iran: Soroush*; 1988. p. Book 3 Part 3, 368.
  6. Rokitanski C. *A manual of pathological anatomy*. Philadelphia, PA: Blanchard & Lea; 1855.
  7. Stein I, Leventhal M. Amenorrhea associated with bilateral polycystic ovaries. *Am J Obstet Gynecol* 1935;29:181-5.
  8. Fauser BC, Tarlatzis BC, Rebar RW, Legro RS, Balen AH, Lobo R, et al. Consensus on women's health aspects of polycystic ovary syndrome (PCOS): the Amsterdam ESHRE/ASRM-Sponsored 3rd PCOS Consensus Workshop Group. *Fertil Steril* 2012 Jan;97(1):28-38. e25.
  9. National Institute of Health. Evidence-based Methodology Workshop on Polycystic Ovary Syndrome, 3–5 December 2012. ([http://prevention.nih.gov/workshops/2012/pcos/docs/PCOS\\_Final\\_Statement.pdf](http://prevention.nih.gov/workshops/2012/pcos/docs/PCOS_Final_Statement.pdf)).
  10. Azziz R, Carmina E, Dewailly D, Diamanti-Kandarakis E, Escobar-Morreale HF, Futterweit W, et al. The Androgen Excess and PCOS Society criteria for the polycystic ovary syndrome: the complete task force report. *Fertil Steril* 2009 Feb;91(2):456-88.
  11. Barry JA, Kuczmierczyk AR, Hardiman PJ. Anxiety and depression in polycystic ovary syndrome: a systematic review and meta-analysis. *Hum Reprod* 2011 Sep;26(9):2442-51.
  12. de Groot PCM, Dekkers OM, Romijn JA, Dieben SWM, Helmerhorst FM. PCOS, coronary heart disease, stroke and the influence of obesity: a systematic review and meta-analysis. *Hum Reprod Update* 2011 Jul-Aug; 17 (4):495-500.
  13. Lim SS, Norman RJ, Davies MJ, Moran LJ. The effect of obesity on polycystic ovary syndrome: a systematic review and meta-analysis. *Obes Rev* 2013 Feb;14(2):95-109.
  14. Moran LJ, Misso ML, Wild RA, Norman RJ. Impaired glucose tolerance, type 2 diabetes and metabolic syndrome in polycystic ovary syndrome: a systematic review and meta-analysis. *Hum Reprod Update* 2010 Jul-Aug;16(4):347-63.
  15. Wild RA, Carmina E, Diamanti-Kandarakis E, Dokras A, Escobar-Morreale HF, Futterweit W, et al. Assessment of cardiovascular risk and prevention of cardiovascular disease in women with the polycystic ovary syndrome: a consensus statement by the Androgen Excess and Polycystic Ovary Syndrome (AE-PCOS) Society. *J Clin Endocrinol Metab* 2010 May;95(5):2038-49.
  16. Randevara HS, Tan BK, Weickert MO, Lois K, Nestler JE, Sattar N, et al. Cardiometabolic aspects of the polycystic ovary syndrome. *Endocr Rev* 2012 Oct;33(5):812-41.
  17. Diamanti-Kandarakis E, Dunaif A. Insulin resistance and the polycystic ovary syndrome revisited: an update on mechanisms and implications. *Endocr Rev* 2012 Dec;33(6):981-1030.
  18. Lim SS, Davies MJ, Norman RJ, Moran LJ. Overweight, obesity and central obesity in women with polycystic ovary syndrome: a systematic review and meta-analysis. *Hum Reprod Update* 2012 Nov-Dec;18(6):618-37.
  19. Toulis KA, Goulis DG, Mintziori G, Kintiraki E, Eukarpidis E, Mouratoglou SA, et al. Meta-analysis of cardiovascular disease risk markers in women with polycystic ovary syndrome. *Hum Reprod Update* 2011 Nov-Dec;17(6):741-60.
  20. Baranova A, Tran TP, Birerdinc A, Younossi ZM. Systematic review: association of polycystic ovary syndrome with metabolic syndrome and non-alcoholic fatty liver disease. *Aliment Pharmacol Ther* 2011 Apr;33(7):801-14.
  21. NICE C. National Institute of Health and Care Excellence; Type 2 Diabetes. Full Guidance. 26 January 2011; Available at: <http://www.nice.org.uk/nicemedia/live/11983/40803/40803.pdf>. Accessed 08 August, 2013.
  22. Inzucchi SE, Bergenstal RM, Buse JB, Diamant M, Ferrannini E, Nauck M, et al. Management of hyperglycemia in type 2 diabetes: a patient-centered approach: position statement of the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care* 2012

- Jun;35(6):1364-79.
23. De Silva D. *Helping people help themselves*; Health Foundation, London; 2011: pp10-17.
  24. NICE P. The most appropriate means of generic and specific interventions to support attitude and behaviour change at population and community levels. NICE DSU 2007 2007;6 (<http://www.nice.org.uk/ph6>).
  25. Gillies CL, Lambert PC, Abrams KR, Sutton AJ, Cooper NJ, Hsu RT, et al. Different strategies for screening and prevention of type 2 diabetes in adults: cost effectiveness analysis. *BMJ* 2008 May 24;336 (7654):1180-5.
  26. NICE P. Preventing type 2 diabetes: risk identification and interventions for individuals at high risk. 2012(<http://publications.nice.org.uk/preventing-type-2-diabetes-risk-identification-and-interventions-for-individuals-at-high-risk-ph38/introduction-scope-and-purpose-of-this-guidance>).
  27. Schwarz PE, Greaves CJ, Lindstrom J, Yates T, Davies MJ. Nonpharmacological interventions for the prevention of type 2 diabetes mellitus. *Nat Rev Endocrinol* 2012 Jan 17;8(6):363-73.
  28. Jarvis J, Skinner TC, Carey ME, Davies MJ. How can structured self-management patient education improve outcomes in people with type 2 diabetes? *Diabetes Obes Metab* 2010 Jan;12(1):12-9.
  29. Troughton J, Jarvis J, Skinner C, Robertson N, Khunti K, Davies M. Waiting for diabetes: perceptions of people with pre-diabetes: a qualitative study. *Patient Educ Couns* 2008 Jul;72(1):88-93.
  30. Ching HL, Burke V, Stuckey BG. Quality of life and psychological morbidity in women with polycystic ovary syndrome: body mass index, age and the provision of patient information are significant modifiers. *Clin Endocrinol (Oxf)* 2007 Mar;66(3):373-9.
  31. Leventhal H, Benyamini Y, Shafer C. Lay beliefs about health and illness. In: Ayers S, editor. *Cambridge handbook of Psychology, Health and Medicine*. Cambridge: Cambridge University Press; 2007.
  32. Ogden J. *Health Psychology; a textbook*. 5th ed. Berkshire, England: McGraw-Hill Open University Press; 2012: pp xx-xx
  33. Skinner TC, Carey ME, Cradock S, Daly H, Davies MJ, Doherty Y, et al. Diabetes Education and Self-Management for Ongoing and Newly Diagnosed (DESMOND): process modelling of pilot study. *Patient Educ Couns* 2006 Dec;64(1-3):369-77.
  34. Dowdy D. Emotional needs of teens with polycystic ovary syndrome. *J Pediatr Nurs* 2012 Feb;27(1):55-64.
  35. Snyder BS. The lived experience of women diagnosed with polycystic ovary syndrome. *J Obstet Gynecol Neonatal Nurs* 2006 May-Jun;35(3):385-92.
  36. Gibson-Helm ME, Lucas IM, Boyle JA, Teede HJ. Women's experiences of polycystic ovary syndrome diagnosis. *Fam Pract* 2014 Oct;31(5):545-9.
  37. Crete J, Adamshick P. Managing polycystic ovary syndrome: what our patients are telling us. *J Holist Nurs* 2011 Dec;29(4):256-66.
  38. Sills ES, Perloe M, Tucker MJ, Kaplan CR, Genton MG, Schattman GL. Diagnostic and treatment characteristics of polycystic ovary syndrome: descriptive measurements of patient perception and awareness from 657 confidential self-reports. *BMC Womens Health* 2001;1(1):3.
  39. Moran L, Gibson-Helm M, Teede H, Deeks A. Polycystic ovary syndrome: a biopsychosocial understanding in young women to improve knowledge and treatment options. *J Psychosom Obstet Gynaecol* 2010 Mar;31(1):24-31.
  40. Ching HL, Burke V, Stuckey BG. Quality of life and psychological morbidity in women with polycystic ovary syndrome: body mass index, age and the provision of patient information are significant modifiers. *Clin Endocrinol (Oxf)* 2007 Mar;66(3):373-9.
  41. Colwell K, Lujan ME, Lawson KL, Pierson RA, Chizen DR. Women's perceptions of polycystic ovary syndrome following participation in a clinical research study: implications for knowledge, feelings, and daily health practices. *J Obstet Gynaecol Can* 2010 May;32(5):453-9.
  42. Avery JC, Braunack-Mayer AJ. The information needs of women diagnosed with Polycystic Ovarian Syndrome--implications for treatment and health outcomes. *BMC Womens Health* 2007 Jun 20;7:9.
  43. Dean E. An Analysis of Online Resources for Women with Polycystic Ovary Syndrome. *Journal of Consumer Health On the Internet* 2011;15(4):361-9.
  44. Percy CA, Gibbs T, Potter L, Boardman S. Nurse-led peer support group: experiences of women with polycystic ovary syndrome. *J Adv Nurs* 2009 Oct;65(10):2046-55.
  45. Hoeger K, Davidson K, Kochman L, Cherry T, Kopin L, Guzick DS. The impact of metformin, oral contraceptives, and lifestyle modification on polycystic ovary syndrome in obese adolescent women in two randomized, placebo-controlled clinical trials. *Journal of Clinical Endocrinology & Metabolism* 2008 Nov;93(11):4299-306.

46. Kasim-Karakas SE, Almario RU, Cunningham W. Effects of protein versus simple sugar intake on weight loss in polycystic ovary syndrome (according to the National Institutes of Health criteria). *Fertil Steril* 2009 July 2009;92(1):262-70.
47. Mehrabani HH, Salehpour S, Amiri Z, Farahani SJ, Meyer BJ, Tahbaz F. Beneficial effects of a high-protein, low-glycemic-load hypocaloric diet in overweight and obese women with polycystic ovary syndrome: a randomized controlled intervention study. *J Am Coll Nutr* 2012 Apr;31(2):117-25.
48. Atiomo W, Read A, Golding M, Silcocks P, Razali N, Sarkar S, et al. Local recruitment experience in a study comparing the effectiveness of a low glycaemic index diet with a low calorie healthy eating approach at achieving weight loss and reducing the risk of endometrial cancer in women with polycystic ovary syndrome (PCOS). *Contemp Clin Trials* 2009 Sep;30(5):451-6.
49. Jedel E, Labrie F, Oden A, Holm G, Nilsson L, Janson PO, et al. Impact of electro-acupuncture and physical exercise on hyperandrogenism and oligo/amenorrhea in women with polycystic ovary syndrome: a randomized controlled trial. *Am J Physiol Endocrinol Metab* 2011 Jan;300(1):E37-45.
50. Nybacka A, Carlstrom K, Stahle A, Nyren S, Hellstrom PM, Hirschberg AL. Randomized comparison of the influence of dietary management and/or physical exercise on ovarian function and metabolic parameters in overweight women with polycystic ovary syndrome. *Fertil Steril* 2011 Dec;96(6):1508-13.
51. Galletly C, Moran L, Noakes M, Clifton P, Tomlinson L, Norman R. Psychological benefits of a high-protein, low-carbohydrate diet in obese women with polycystic ovary syndrome--a pilot study. *Appetite* 2007 Nov;49(3):590-3.
52. Bruner B, Chad K, Chizen D. Effects of exercise and nutritional counseling in women with polycystic ovary syndrome. *Applied Physiology, Nutrition, & Metabolism = Physiologie Appliquee, Nutrition et Metabolisme* 2006 Aug;31(4):384-91.
53. Thomson RL, Buckley JD, Noakes M, Clifton PM, Norman RJ, Brinkworth GD. The effect of a hypocaloric diet with and without exercise training on body composition, cardiometabolic risk profile, and reproductive function in overweight and obese women with polycystic ovary syndrome. *J Clin Endocrinol Metab* 2008 September 2008;93(9):3373-80.
54. Moran LJ, Hutchison SK, Norman RJ, Teede HJ. Lifestyle changes in women with polycystic ovary syndrome. *Cochrane Database Syst Rev* 2011 Jul 6;(7):CD007506. doi(7):CD007506.
55. Moran LJ, Ko H, Misso M, Marsh K, Noakes M, Talbot M, et al. Dietary composition in the treatment of polycystic ovary syndrome: a systematic review to inform evidence-based guidelines. *J Acad Nutr Diet* 2013 Apr;113(4):520-45.
56. Lass N, Kleber M, Winkel K, Wunsch R, Reinehr T. Effect of lifestyle intervention on features of polycystic ovarian syndrome, metabolic syndrome, and intima-media thickness in obese adolescent girls. *J Clin Endocrinol Metab* 2011 Nov;96(11):3533-40.
57. Sorensen LB, Soe M, Halkier KH, Stigsby B, Astrup A. Effects of increased dietary protein-to-carbohydrate ratios in women with polycystic ovary syndrome. *Am J Clin Nutr* 2012 Jan;95(1):39-48.
58. Azziz R, Marin C, Hoq L, Badamgarav E, Song P. Health care-related economic burden of the polycystic ovary syndrome during the reproductive life span. *J Clin Endocrinol Metab* 2005 Aug;90(8):4650-8.
59. Gillies CL, Lambert PC, Abrams KR, Sutton AJ, Cooper NJ, Hsu RT, et al. Different strategies for screening and prevention of type 2 diabetes in adults: cost effectiveness analysis. *BMJ* 2008 May 24;336(7654):1180-5.
60. Johnson M, Jones R, Freeman C, Woods HB, Gillett M, Goyder E, et al. Can diabetes prevention programs be translated effectively into real-world settings and still deliver improved outcomes? A synthesis of evidence. *Diabet Med* 2013 Jan;30(1):3-15.
61. Yates T, Davies M, Gorely T, Bull F, Khunti K. Effectiveness of a pragmatic education program designed to promote walking activity in individuals with impaired glucose tolerance: a randomized controlled trial. *Diabetes Care* 2009 Aug;32(8):1404-10.
62. Davies MJ, Heller S, Skinner TC, Campbell MJ, Carey ME, Cradock S, et al. Effectiveness of the diabetes education and self management for ongoing and newly diagnosed (DESMOND) program for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial. *BMJ* 2008 Mar 1;336(7642):491-5.
63. Khunti K, Gray LJ, Skinner T, Carey ME, Realf K, Dallosso H, et al. Effectiveness of a diabetes education and self management program (DESMOND) for people with newly diagnosed type 2 diabetes mellitus: three year follow-up of a cluster randomised controlled trial in primary care. *BMJ* 2012 Apr 26;344:e2333.
64. Gillett M, Dallosso HM, Dixon S, Brennan A, Carey ME, Campbell MJ, et al. Delivering the diabetes



education and self management for ongoing and newly diagnosed (DESMOND) program for people with newly diagnosed type 2 diabetes: cost effectiveness analysis. *BMJ* 2010 Aug 20;341:c4093.

65. DESMOND. Walking Away from Diabetes. June 2013; Available at: <http://www.desmond-project.org.uk/walkingaway-280.html>. Accessed 17/06, 2013.
66. Prochaska JO, DiClemente CC. Self change processes, self efficacy and decisional balance across five stages of smoking cessation. *Prog Clin Biol Res* 1984;156:131-40.