

# Self-management Education Programs in Chronic Disease

## A Systematic Review and Methodological Critique of the Literature

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**Background:** Self-management programs have been widely reported to help patients manage symptoms and contain utilization of health care resources for several chronic conditions, but to date no systematic review across multiple chronic diseases has been reported. We evaluated the efficacy of patient self-management educational programs for chronic diseases and critically reviewed their methodology.

**Methods:** We searched MEDLINE and HealthSTAR for the period January 1, 1964, through January 31, 1999, then hand searched the reference section of each article for other relevant publications. We included studies if a self-management education intervention for a chronic disease was reported, a concurrent control group was included, and clinical outcomes were evaluated. Two authors reviewed each study and extracted the data on clinical outcomes.

**Results:** We included 71 trials of self-management education. Trial methods varied substantially and were sub-

optimal. Diabetic patients involved with self-management education programs demonstrated reductions in glycosylated hemoglobin levels (summary effect size, 0.45; 95% confidence interval [CI], 0.17-0.74); diabetic patients had improvement in systolic blood pressure (summary effect size, 0.20; 95% CI, 0.01-0.39); and asthmatic patients experienced fewer attacks (log rate ratio, 0.59; 95% CI, 0.35-0.83). Although we found a trend toward a small benefit, arthritis self-management education programs were not associated with statistically significant effects. Evidence of publication bias existed.

**Conclusions:** Self-management education programs resulted in small to moderate effects for selected chronic diseases. In light of evidence of publication bias, further trials that adhere to a standard methodology would help clarify whether self-management education is worthwhile.

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**M**ORE THAN 100 MILLION people in the United States have a chronic disease, and more than \$650 billion is spent managing chronic diseases each year.<sup>1</sup> Because of the nature of chronic disease, management varies over time, with treatments adjusted according to changes in patient symptoms and fluctuations in the disease process. Consequently, the patient plays an integral role in the management of chronic disease.<sup>2,3</sup> The Institute of Medicine report entitled *Crossing the Quality Chasm: A New Health System for the 21st Century* acknowledged self-management education as an important aspect of quality care.<sup>4</sup> However, such programs have typically received less scrutiny than other types of health care interventions.

Self-management programs facilitate acquisition by the patient of preventive or therapeutic health care activities,

often in collaboration with health care providers.<sup>5</sup> Self-management education programs emphasize the role of patient education in preventive and therapeutic health care activities and usually consist of organized learning experiences designed to facilitate adoption of health-promoting behaviors. Such programs usually are separate from clinical patient care, but are often run in collaboration with health care professionals.<sup>3</sup> Self-management education programs exist for many chronic conditions, including arthritis, asthma, diabetes, and hypertension. Previous reviews have been limited to a specific chronic disease and have suggested small benefits.<sup>6-8</sup>

We conducted a structured review of trials of self-management education programs for chronic diseases to examine their efficacy. We critically reviewed their methodology and assessed whether specific features of education programs from across the selected chronic diseases were associated

with better clinical outcomes. We hypothesized that the effects of self-management education programs would vary by disease, but that common characteristics of programs across diseases would correlate with effect size.

## METHODS

### IDENTIFICATION OF LITERATURE

We searched MEDLINE and HealthSTAR for English-language publications from January 1, 1964, through January 31, 1999, with the following medical subject headings: self-management, self-care, demand management, patient education, self-efficacy, social learning theory, arthritis, osteoarthritis, rheumatoid arthritis, diabetes, hypertension, asthma, hypertension, congestive heart failure, and chronic disease. Screening the reference lists of each of the articles identified additional relevant publications.

Each article obtained through the search strategy was reviewed by two of us (A.W. and D.H.S.) to determine whether the article met the inclusion criteria. Articles were considered for review if (1) the intervention contained a self-management education component, (2) a concurrent control group was included, and (3) clinical outcomes were evaluated. Included articles were not limited to randomized trials and included some nonrandom studies. We were concerned about the heterogeneity of studies and thus excluded studies that (1) exclusively reported outcomes such as knowledge, compliance, self-efficacy (confidence in one's ability to perform self-management activities), satisfaction, or use of health care services; (2) exclusively assessed generic outcomes such as quality of life or coping skills; (3) focused on chronic emotional disorders such as depression, postacute care (eg, for myocardial infarction), obesity, or smoking cessation programs; or (4) exclusively involved physical or psychosocial therapies, such as biofeedback, relaxation techniques, exercise, and group therapy. Studies that integrated such therapies into an educational program were included. These exclusion criteria were applied across all chronic disease to improve the comparability of studies.

### DATA ABSTRACTION

Articles that met the inclusion criteria were independently reviewed by 2 of 3 authors (A.W., P.S.W., and D.H.S.) using a structured abstraction form (available upon request). We examined each study to determine recruitment procedures, whether and how subjects were randomized, patient demographics, noncompletion (dropout) rates, educational methods, and clinical outcomes. We assessed sample sizes before and after dropout. Several studies reported only the total sample size, not the size for each treatment arm. In these instances, the total sample size was evenly divided between the number of treatment groups. When trials involved multiple treatment arms, we combined the groups that included self-management education. The dropout rate was calculated using the following formula:

$$[(1 - \text{Number of Patients at Follow-up}) / \text{Number of Patients at Start}] \times 100\%$$

We abstracted information regarding the following characteristics specific to the educational program: the duration of education, number of educational sessions or education contacts, background training of educators (eg, medicine, nursing, social work, health education), setting of the educational program (inpatient vs outpatient), educational format (group vs individual), method of education (written, audiotape, videotape, telephone, or face-to-face), and use of a formal syllabus. Fol-

low-up duration was defined as the period beginning with the baseline assessment through the last follow-up. We also reviewed each study to ascertain whether a behavioral science model was used in designing the educational program. Two common frameworks included cognitive behavior therapy<sup>9</sup> and social cognitive theory, in which self-efficacy is an important construct.<sup>10</sup>

After reviewing all articles, we determined the clinical outcomes studied most frequently for each chronic disease. These outcomes included pain and disability for arthritis; systolic and diastolic blood pressures for hypertension; glycosylated hemoglobin and fasting blood glucose levels for diabetes; and forced expiratory volume in 1 second and frequency of attacks for asthma, including emergency department visits, hospitalizations for asthma, and physician visits for asthma. For other conditions, or if none of these outcomes was measured, we recorded the primary end point reported by the author.

### ANALYSIS

Effect sizes are unitless measures of a treatment effect used for pooling the results of trials that may use different outcome measures. If an intervention's effect is equal to that of placebo, then the effect size is 0. Effect sizes of less than 0.2 are considered small; those of 0.2 to 0.5, moderate; and those of greater than 0.5, large. We calculated summary effect sizes for each end point described in the preceding section. The effect size was defined as the final end point value of the control group minus that value for the experimental group, divided by the standard deviation of the end point in the control group.<sup>11</sup> Dichotomous outcomes, such as reaching the goal for blood glucose level, were converted to effect sizes using the method of Chinn.<sup>12</sup> No validated method was available for conversion of count data, such as the number of admissions to the emergency department for asthma; these results were separately calculated as rate ratios.<sup>13</sup> Review of the trials' methodologies suggested substantial heterogeneity; therefore we decided a priori to use a random-effects model for the primary analyses.<sup>14</sup> We formally assessed heterogeneity using the Q statistic<sup>9</sup> and reanalyzed the data using a fixed-effects model.

We then fit a metaregression model across chronic diseases to identify which variables were associated with greater clinical benefits. The metaregression model assumed a random-effects linear relationship and weighted for the effect measured in each study. As some studies contributed 2 correlated outcome measures to the regression model (such as pain and disability for an arthritis study), we used a generalized estimating equation correction for correlation within studies.<sup>15</sup> The dependent variable was the pooled effect size across all chronic diseases. Each chronic disease and its end point were represented as indicator variables. Other independent variables included were the percentage of dropouts, number of educational sessions, program duration, program format, education mode, and reference to a behavioral model. We also ran linear regression models assuming the fixed-effects weighting. All regression analyses were performed using the GENMOD procedure in SAS (version 8.0; SAS Institute Inc, Cary, NC).

We assessed for the possibility of publication bias by generating funnel plots. These plots typically graph the effect size of a study on the horizontal axis and the sample size of the study on the vertical axis. If no publication bias exists, studies with larger sample sizes will have smaller variations in effects, and the effects of smaller studies will range equally above (to the right) and below (to the left) this value; therefore, the plot would take on the shape of an inverted funnel. However, in the presence of bias against publishing results that are null or negative, the funnel plot would be asymmetric, with fewer values populating the left side of the funnel. We first created funnel plots by disease type and outcome, and then generated a plot for all the trials in-

**Table 1. Demographic Attributes of Populations of All Studies Included in the Meta-analysis**

| Source   | Study Design* | Total No. | % Dropout | Mean Age, y | % Female | Recruitment Site  |
|--|---------------|-----------|-----------|-------------|----------|-------------------|
| <b>Arthritis</b>   |               |           |           |             |          |                   |
| Applebaum et al, <sup>16</sup> 1988                                    | RCT, block    | 18        | 44        | 62          | 11       | Clinic            |
| Barlow and Wright, <sup>17</sup> 1998                                  | RCT, patient  | 95        | 12        | 58          | 81       | NA                |
| Barlow and Barefoot, <sup>18</sup> 1996                                | RCT, patient  | 58        | 10        | 42          | 42       | Clinic            |
| Bradley et al, <sup>19</sup> 1987                                      | RCT, patient  | 68        | 22        | 51          | 81       | Clinic            |
| Burckhardt et al, <sup>20</sup> 1994                                   | RCT, patient  | 99        | 13        | 47          | 100      | Clinic            |
| Cohen et al, <sup>21</sup> 1986  | RCT, patient  | 96        | 10        | 66          | 78       | Clinic, ads       |
| Fries et al, <sup>22</sup> 1997  | RCT, patient  | 1099      | 26        | 64          | 72       | Clinic            |
| Keefe et al, <sup>23,24</sup> 1990                                     | RCT, patient  | 99        | 6         | 64          | 72       | Clinic            |
| Lindroth et al, <sup>25</sup> 1995; Lindroth et al, <sup>26</sup> 1989 | Nonrandom     | 196       | 53        | 61          | 71       | Clinic            |
| Lorig et al, <sup>27</sup> 1989; Lorig et al, <sup>28</sup> 1985       | RCT, block    | 854       | 18        | 64          | 84       | Print ads         |
| Lorig et al, <sup>29</sup> 1986  | RCT, patient  | 100       | 15        | 65          | 73       | Print ads         |
| Maggs et al, <sup>30</sup> 1996  | RCT, block    | 162       | 7         | 57          | 69       | Clinic            |
| Maisiak et al, <sup>31</sup> 1996                                      | RCT, block    | 405       | 6         | 61          | NA       | Clinic, newspaper |
| Mazzuca et al, <sup>32</sup> 1997                                      | Nonrandom     | 211       | 22        | 62          | 85       | Clinic            |
| Neuberger et al, <sup>33</sup> 1993                                    | RCT, patient  | 98        | 46        | 53          | 66       | Clinic            |
| Nicassio et al, <sup>34</sup> 1997                                     | RCT, block    | 94        | 9         | 53          | 88       | Clinic            |
| Parker et al, <sup>35</sup> 1988                                       | RCT, patient  | 83        | 0         | 61          | 4        | Clinic            |
| Radojevic et al, <sup>36</sup> 1992                                    | RCT, patient  | 65        | 9         | 54          | 76       | Clinic            |
| Riemsma et al, <sup>37</sup> 1997                                      | RCT, block    | 249       | 13        | 58          | 66       | Clinic            |
| Shearn and Fireman, <sup>38</sup> 1985                                 | RCT, patient  | 105       | 23        | 56          | 76       | Clinic            |
| Simeoni et al, <sup>39</sup> 1995                                      | Nonrandom     | 175       | 29        | 66          | 81       | Clinic            |
| Strauss et al, <sup>40</sup> 1986                                      | RCT, patient  | 57        | 23        | 54          | 81       | Clinic            |
| Vlaeyen et al, <sup>41</sup> 1996                                      | RCT, patient  | 131       | 45        | 44          | 88       | Clinic            |
| Weinberger et al, <sup>42</sup> 1989                                   | RCT, patient  | 439       | 11        | 62          | 88       | Clinic            |
| <b>Asthma</b>  |               |           |           |             |          |                   |
| Bailey et al, <sup>43</sup> 1990                                       | RCT, patient  | 267       | 16        | 45          | 66       | Clinic            |
| Bolton et al, <sup>44</sup> 1991                                       | RCT, patient  | 241       | 30        | 38          | 66       | ED                |
| Clark et al, <sup>45</sup> 1986  | RCT, patient  | 310       | 17        | 9           | 36       | Clinic            |
| Evans et al, <sup>46</sup> 1987  | RCT, block    | 239       | 33        | 9           | 41       | School            |
| Fireman et al, <sup>47</sup> 1981                                      | Nonrandom     | 26        | 0         | 7           | 19       | Clinic            |
| Ford et al, <sup>48</sup> 1997   | RCT, block    | 241       | 41        | 37          | 66       | Clinic            |
| Garrett et al, <sup>49</sup> 1994                                      | RCT, patient  | 500       | 10        | NA          | 58       | ED                |
| Hilton et al, <sup>50</sup> 1986                                       | Nonrandom     | 339       | 19        | NA          | NA       | Clinic            |
| Ignacio-Garcia and Gonzalez-Santos, <sup>51</sup> 1995                 | RCT, patient  | 94        | 26        | 42          | 54       | Clinic            |
| Jones et al, <sup>52</sup> 1995  | RCT, patient  | 121       | 40        | 29          | 63       | Clinic            |
| Lahdensuo et al, <sup>53</sup> 1996                                    | RCT, block    | 122       | 6         | 42          | 63       | Clinic            |
| LeBaron et al, <sup>54</sup> 1985                                      | RCT, patient  | 43        | 28        | 11          | 26       | Clinic            |
| Snyder et al, <sup>55</sup> 1987                                       | RCT, patient  | 79        | 5         | 28          | 55       | Clinic, newspaper |
| Verver et al, <sup>56</sup> 1996                                       | RCT, patient  | 48        | 0         | 53          | 40       | Clinic            |
| Wilson et al, <sup>57</sup> 1993                                       | RCT, block    | 323       | 14        | NA          | NA       | Clinic            |
| Yoon et al, <sup>58</sup> 1993   | RCT, patient  | 76        | 26        | 32          | 74       | Inpatient         |

(continued)

cluded in the metaregression. Because each chronic disease had a different pooled summary effect size, to standardize across different diseases we plotted the residual values of each study from the weighted linear regression model on the horizontal axis and the random-effects weight on the vertical axis.<sup>13</sup>

## RESULTS

Our search identified 305 potentially eligible trials. We subsequently excluded trials without a control group (n=38), without clinical outcomes (n=37), without a clear self-management education component (n=68), that did not focus on any of the included chronic diseases (n=11), or that did not include primary data (n=80). The analysis therefore included the 71 trials presented in **Table 1** and **Table 2** categorized into the following 5 disease groups: arthritis (n=24); asthma (n=16); diabetes (n=16); hypertension (n=10); and miscellaneous chronic dis-

eases (n=5). This last group included venous thromboembolism requiring long-term anticoagulation therapy, coronary artery disease, and chronic cancer pain. The population in the 71 trials had a mean age of 48 years, and 54% were female. The average dropout rate was 17% across all diseases, ranging from 20% in the arthritis self-management education trials to 16% in the diabetes trials.

We first assessed the methods used for conducting and reporting each trial. Eleven (15%) of the 71 trials did not randomize subjects but rather used a convenience sample of concurrent controls. Of the randomized controlled trials, 20 (33%) randomized at the level of the clinic or the physician. Blocked randomization such as this allows for the possibility of a center effect, which was not assessed in any of the trials. Seventeen (24%) of the trials did not describe a formal syllabus for the education program. Program duration and time of final assessment varied from 1 to 72 weeks. There were 8 analyses (11%) conducted using an

**Table 1. Demographic Attributes of Populations of All Studies Included in the Meta-analysis (cont)**

| Source   | Study Design*               | Total No. | % Dropout | Mean Age, y | % Female | Recruitment Site |
|--|-----------------------------|-----------|-----------|-------------|----------|------------------|
| <b>Diabetes</b>  |                             |           |           |             |          |                  |
| Anderson et al, <sup>59</sup> 1989   | RCT, patient                | 70        | 14        | 13          | 53       | Clinic           |
| Bloomgarden et al, <sup>60</sup> 1987  | RCT, patient                | 302       | 12        | 58          | 72       | Clinic           |
| Falkenberg et al, <sup>61</sup> 1986   | RCT, patient                | 45        | 27        | 66          | 55       | Clinic           |
| Gilden et al, <sup>62</sup> 1992   | Nonrandom                   | 32        | NA        | 68          | 0        | Clinic           |
| Kaplan et al, <sup>63</sup> 1985   | RCT, patient                | 21        | 10        | 8           | 62       | Clinic           |
| Kaplan et al, <sup>64</sup> 1987   | RCT, block                  | 76        | 8         | 58          | 58       | Newspaper        |
| Korhonen et al, <sup>65</sup> 1983   | RCT, patient                | 77        | 0         | 33          | 45       | Clinic           |
| Kronsbein et al, <sup>66</sup> 1988  | Nonrandom                   | 127       | 22        | 64          | 60       | Clinic           |
| Malone et al, <sup>67</sup> 1989   | RCT, patient                | 203       | 10        | NA          | NA       | Clinic           |
| Mazucca et al, <sup>68</sup> 1986  | RCT, block                  | 542       | 44        | 58          | 79       | Clinic           |
| Mulhauser et al, <sup>69</sup> 1987  | RCT, block                  | 300       | 8         | 26          | 43       | Inpatient        |
| Raz et al, <sup>70</sup> 1988  | RCT, block                  | 51        | 4         | 52          | 35       | Clinic           |
| Rettig et al, <sup>71</sup> 1986   | RCT, patient                | 471       | 21        | 52          | 75       | Inpatient        |
| Starostina et al, <sup>72</sup> 1994   | Nonrandom                   | 181       | 9         | 29          | 55       | Inpatient        |
| Vinacor et al, <sup>73</sup> 1987  | RCT, block                  | 246       | 44        | 57          | 79       | Clinic           |
| Wilson and Pratt, <sup>74</sup> 1987   | RCT, location               | 79        | 0         | 68          | 80       | Senior centers   |
| <b>Hypertension</b>  |                             |           |           |             |          |                  |
| Cupples and McKnight, <sup>75</sup> 1994   | RCT, patient                | 688       | 10        | 63          | 41       | Clinic           |
| Garcia-Vera et al, <sup>76</sup> 1997  | NA                          | 43        | 9         | 45          | NA       | Clinic           |
| Gonzalez-Fernandez et al, <sup>77</sup> 1990   | RCT, patient                | 59        | 17        | 59          | 36       | Inpatient        |
| Iso et al, <sup>78</sup> 1996  | RCT, block                  | 111       | 30        | 59          | 52       | Community center |
| Martinez et al, <sup>79</sup> 1990   | RCT, patient                | 722       | NA        | 61          | 59       | Clinic           |
| Levine et al, <sup>80</sup> 1979; Morisky et al, <sup>81</sup> 1980; Morisky et al, <sup>82,83</sup> 1982; Morisky et al, <sup>84</sup> 1983 | Randomized factorial design | 100       | 28        | 54          | 76       | Clinic           |
| Mulhauser et al, <sup>85</sup> 1993  | RCT, block                  | 200       | 20        | 51          | 55       | Clinic           |
| Sawicki et al, <sup>86</sup> 1995  | Nonrandom                   | 91        | 4         | 36          | 47       | Clinic           |
| Stahl et al, <sup>87</sup> 1984  | RCT, patient                | 396       | 32        | 47          | 58       | Clinic           |
| Watkins et al, <sup>88</sup> 1987  | RCT, block                  | 414       | 0         | NA          | 59       | Clinic           |
| <b>Miscellaneous</b>   |                             |           |           |             |          |                  |
| Ansell et al, <sup>89</sup> 1995   | Nonrandom                   | 43        | 7         | 46          | 42       | Clinic           |
| Clark et al, <sup>90</sup> 1992  | RCT, patient                | 324       | 24        | 70          | 41       | Clinic           |
| de Wit et al, <sup>91</sup> 1997   | RCT, block                  | 209       | 22        | 54          | 59       | Clinic           |
| Oldenburg et al, <sup>92</sup> 1995  | RCT, block                  | 91        | 5         | 59          | 9        | Inpatient        |
| Sawicki, <sup>93</sup> 1999  | RCT, patient                | 179       | 8         | 55          | 30       | Clinic           |

Abbreviations: ED, emergency department; NA, not applicable or not available; RCT, randomized controlled trial.

\*Randomization occurred by patient or in blocks, usually by location, ie, randomized by clinics.

intention-to-treat method. Two (3%) of the 71 interventions were conducted by investigators independent of the developer of the self-management education program.

Summary effect sizes for each predetermined end point of interest are presented in **Table 3**. Significant heterogeneity was noted within end points (Q statistic  $P < .10$  for 4 of 8 end points). The analysis indicated that overall summary effect sizes for self-management education programs were small to modest (range, 0.01-0.46 for random-effects models). Such programs were associated with significant improvements only in glycosylated hemoglobin levels for persons with diabetes (summary effect size, 0.46; 95% confidence interval [CI], 0.17-0.74) and systolic blood pressure for those with hypertension (summary effect size, 0.20; 95% CI, 0.01-0.39). Summary effect sizes were similar for fixed- and random-effects models, so we present only the random-effects results. We conducted a separate analysis on the rate ratio scale frequency of asthma attack that included the count data. This showed a large reduction in asthma attacks associated with self-management education programs (log rate ratio, 0.59; 95% CI, 0.35-0.83). Although there was a trend toward a small benefit, ar-

thritis self-management education programs were not associated with statistically significant effects.

All end points from all diseases were included in a metaregression. After adjusting for all variables listed as well as the diseases and end points, the only variable associated with improved outcomes was face-to-face education ( $\beta$  population regression coefficient, 0.15; 95% CI, 0.03-0.42). Program duration, number of educational sessions, format, and use of a behavioral science model were not significantly associated with improved efficacy. The funnel plot presented in the **Figure** suggests that there may have been some publication bias against reporting null or negative trials of self-management education programs. Individual plots by disease category suggested that this bias existed most clearly in the reporting of glycosylated hemoglobin levels in trials with diabetic patients and systolic and diastolic blood pressures in patients with hypertension.

#### COMMENT

To our knowledge, this is the largest structured review to date of trials testing self-management education

**Table 2. Methodological Attributes of All Studies Included in the Meta-analysis**

| Source  | Formal Syllabus | No. of Contacts  | Program Duration, wk | Program Format | Education Mode* | Program Facilitator† | Behavioral Model |
|---|-----------------|--|----------------------|----------------|-----------------|----------------------|------------------|
| <b>Arthritis</b>  |                 |  |                      |                |                 |                      |                  |
| Applebaum et al, <sup>16</sup> 1988                                       | Yes             | 10   | 8                    | NA             | F               | MH                   | CBT              |
| Barlow and Wright, <sup>17</sup> 1998                                     | No              | 1 Leaflet  | 1                    | GP             | W               | NA                   | SCT              |
| Barlow and Barefoot, <sup>18</sup> 1996                                   | Yes             | 12 h   | 1                    | IND            | F, W            | NA                   | SCT              |
| Bradley et al, <sup>19</sup> 1987   | Yes             | 15   | 15                   | GP, IND        | F, W            | MH                   | SCT              |
| Burckhardt et al, <sup>20</sup> 1994                                      | Yes             | 6  | 6                    | GP             | F               | PT                   | SCT              |
| Cohen et al, <sup>21</sup> 1986   | Yes             | 6  | 6                    | GP             | F, W            | OT, PT, RD, MD       | SCT              |
| Fries et al, <sup>22</sup> 1997   | Yes             | 2-3 Mailings   | 26                   | IND            | W, V            | NA                   | SCT              |
| Keefe et al, <sup>23,24</sup> 1990  | Yes             | 10   | 10                   | GP             | F, W, T, A      | RN, MH               | CBT              |
| Lindroth et al, <sup>25</sup> 1995;<br>Lindroth et al, <sup>26</sup> 1989 | Yes             | 6  | 6                    | GP             | F               | HE                   | SCT              |
| Lorig et al, <sup>27</sup> 1989;<br>Lorig et al, <sup>28</sup> 1985       | Yes             | 6  | 6                    | GP             | F, W            | LE                   | SCT              |
| Lorig et al, <sup>29</sup> 1986   | Yes             | 6  | 6                    | GP             | F, W            | LE, PT, MD           | SCT              |
| Maggs et al, <sup>30</sup> 1996   | No              | 1  | 1                    | IND            | F, W            | OT                   | None             |
| Maisiak et al, <sup>31</sup> 1996   | Yes             | 11   | 36                   | IND            | T               | MD                   | RT               |
| Mazzuca et al, <sup>32</sup> 1997   | Yes             | 3  | 4                    | IND            | F, T            | RN                   | None             |
| Neuberger et al, <sup>33</sup> 1993                                       | Yes             | Maximum 4  | 16                   | IND            | W               | RN                   | SCT              |
| Nicassio et al, <sup>34</sup> 1997  | Yes             | 10   | 10                   | GP             | F, V, W         | MH, PT, MD           | CBT              |
| Parker et al, <sup>35</sup> 1988  | Yes             | 1-wk Hospital visit,<br>group visit every<br>1-3 mo                                  | 52                   | GP             | F, W, V         | NA                   | CBT              |
| Radojevic et al, <sup>36</sup> 1992                                       | Yes             | 6  | 6                    | GP             | F, V            | MH                   | CBT              |
| Riemsma et al, <sup>37</sup> 1997   | Yes             | Education packet of<br>video, audio, book,<br>and passport                           | 24                   | IND            | W, V, A         | RN, PT, MD           | SCT              |
| Shearn and Fireman, <sup>38</sup> 1985                                    | No              | 10   | 10                   | GP             | F               | MH                   | None             |
| Simeoni et al, <sup>39</sup> 1995   | No              | 6  | 6                    | GP             | F, W            | HE                   | SCT              |
| Strauss et al, <sup>40</sup> 1986   | No              | 12-24  | 12-24                | GP             | F, A            | MH                   | None             |
| Vlaeyen et al, <sup>41</sup> 1996   | Yes             | 6  | 6                    | GP             | F, W, A         | MH, PT               | CBT              |
| Weinberger et al, <sup>42</sup> 1989                                      | Yes             | Monthly telephone<br>calls and clinic<br>visits up to 44 wk                          | 44                   | IND            | F, T            | LE                   | None             |
| <b>Asthma</b>   |                 |  |                      |                |                 |                      |                  |
| Bailey et al, <sup>43</sup> 1990  | Yes             | 1 Individual session,<br>home study,<br>support group,<br>and telephone call         | 4                    | GP, IND        | F, T            | LE                   | None             |
| Bolton et al, <sup>44</sup> 1991  | Yes             | 3  | 3                    | GP             | F, A, W         | RN                   | None             |
| Clark et al, <sup>45</sup> 1986   | Yes             | 6  | 36                   | GP             | F               | HE                   | None             |
| Evans et al, <sup>46</sup> 1987   | Yes             | 6  | 3                    | GP             | F, W            | HE                   | SCT              |
| Fireman et al, <sup>47</sup> 1981   | No              | 4 h Individual<br>instruction,<br>2 group sessions,<br>and telephone<br>contact      | 52                   | GP, IND        | F, W, T         | RN                   | SCT              |
| Ford et al, <sup>48</sup> 1997  | Yes             | 3  | 1                    | GP             | F, W            | HE                   | None             |
| Garrett et al, <sup>49</sup> 1994   | Yes             | No set No. of<br>sessions; patients<br>discharged when<br>all topics were<br>covered | NA                   | GP, IND        | F, W            | HE                   | None             |
| Hilton et al, <sup>50</sup> 1986  | Yes             | 3 Physician visits,<br>treatment cards,<br>audio, booklets                           | NA                   | IND            | F, W, A         | MD                   | None             |
| Ignacio-Garcia and<br>Gonzalez-Santos, <sup>51</sup> 1995                 | No              | 4  | 36                   | IND            | F, W            | MD                   | None             |
| Jones et al, <sup>52</sup> 1995   | Yes             | 5  | 26                   | IND            | F, W            | RN, MD               | None             |
| Lahdensuo et al, <sup>53</sup> 1996                                       | Yes             | 1  | 1                    | IND            | F, W            | RN, PT               | None             |
| LeBaron et al, <sup>54</sup> 1985   | Yes             | 4  | 16                   | IND            | F               | RN                   | None             |
| Snyder et al, <sup>55</sup> 1987  | Yes             | 2  | 12                   | GP             | F, V, W         | RT                   | SCT              |
| Verver et al, <sup>56</sup> 1996  | Yes             | 2  | 2                    | IND            | F, W            | HE                   | None             |
| Wilson et al, <sup>57</sup> 1993  | Yes             | 3-5, Plus workbook   | 4                    | GP, IND        | F, W            | RN                   | SCT              |
| Yoon et al, <sup>58</sup> 1993  | Yes             | 1  | 1                    | GP             | F, V            | NA                   | None             |

(continued)



**Table 2. Methodological Attributes of All Studies Included in the Meta-analysis (cont)**

| Source  | Formal Syllabus | No. of Contacts  | Program Duration, wk | Program Format | Education Mode* | Program Facilitator† | Behavioral Model                           |
|---|-----------------|--|----------------------|----------------|-----------------|----------------------|--|
| <b>Diabetes</b>   |                 |  |                      |                |                 |                      |  |
| Anderson et al, <sup>59</sup> 1989  | Yes             | 4  | 18                   | GP, IND        | F, T            | RN, MH, RD           | None                                       |
| Bloomgarden et al, <sup>60</sup> 1987   | Yes             | 9  | 72                   | GP             | F, V, A, W      | RD, RA               | None                                       |
| Falkenberg et al, <sup>61</sup> 1986  | Yes             | 8  | 12                   | GP             | F, W            | RN, RD, MD           | Problem-orientated participatory education |
| Gilden et al, <sup>62</sup> 1992  | No              | 24   | 72                   | GP             | F               | MH, RD, MD           | None                                       |
| Kaplan et al, <sup>63</sup> 1985  | No              | 15   | 3                    | GP             | F, V, A         | MH, RD, MD           | SCT  |
| Kaplan et al, <sup>64</sup> 1987  | Yes             | 10   | 10                   | GP             | F               | RD, PT               | None                                       |
| Korhonen et al, <sup>65</sup> 1983  | No              | 15   | 1                    | GP, IND        | F, W            | RN, RD, MD           | None                                       |
| Kronsbein et al, <sup>66</sup> 1988   | Yes             | 4  | 4                    | GP             | F, W            | HE, MD               | None                                       |
| Malone et al, <sup>67</sup> 1989  | Yes             | 1  | 1                    | GP             | F, W, V         | MD                   | None                                       |
| Mazzuca et al, <sup>68</sup> 1986   | Yes             | 3  | 8                    | GP             | F, T, V, A      | RN, RD               | None                                       |
| Mulhauser et al, <sup>69</sup> 1987   | Yes             | 5-d Inpatient education  | 1                    | GP             | F               | RN                   | None                                       |
| Raz et al, <sup>70</sup> 1988   | No              | 3 Weekly lessons every 4 mo                                      | 52                   | GP             | F               | RN, RD, PT, MD       | None                                       |
| Rettig et al, <sup>71</sup> 1986  | No              | 12 Visits  | 34                   | IND            | F, W            | RN                   | None                                       |
| Starostina et al, <sup>72</sup> 1994  | Yes             | 5-d Inpatient education  | 1                    | IND            | F, W            | MD                   | None                                       |
| Vinacor et al, <sup>73</sup> 1987   | Yes             | NA   | 8                    | IND            | F, T, W         | RN, RD               | None                                       |
| Wilson and Pratt, <sup>74</sup> 1987  | No              | 10   | 16                   | GP             | F               | RD, HE               | None                                       |
| <b>Hypertension</b>   |                 |  |                      |                |                 |                      |  |
| Cupples and McKnight, <sup>75</sup> 1994  | No              | 4  | 16                   | IND            | F, W            | HE                   | None                                       |
| Garcia-Vera et al, <sup>76</sup> 1997   | Yes             | 7  | 7                    | IND            | F, V, A, W      | MH                   | Behavioral biofeedback                     |
| Gonzalez-Fernandez et al, <sup>77</sup> 1990  | No              | 4  | 1                    | GP             | F               | HE, MD, RD           | None                                       |
| Iso et al, <sup>78</sup> 1996   | Yes             | 8  | 72                   | GP, IND        | F, T, W         | RN, MD, RD           | None                                       |
| Martinez et al, <sup>79</sup> 1990  | No              | 2  | 8                    | GP, IND        | F, V, A         | RN, MD               | None                                       |
| Levine et al, <sup>80</sup> 1979;<br>Morisky et al, <sup>81</sup> 1980;<br>Morisky et al, <sup>82,83</sup> 1982;<br>Morisky et al, <sup>84</sup> 1983 | Yes             | 6 Sessions, group session, and interview                         | 3                    | GP, IND        | F, W            | LE, MH, RN           | None                                       |
| Mulhauser et al, <sup>85</sup> 1993   | Yes             | 4  | 4                    | GP, IND        | F               | PA                   | None                                       |
| Sawicki et al, <sup>86</sup> 1995   | Yes             | 4  | 4                    | GP             | F               | HE                   | None                                       |
| Stahl et al, <sup>87</sup> 1984   | Yes             | 1  | 1                    | IND            | F               | RN                   | None                                       |
| Watkins et al, <sup>88</sup> 1987   | Yes             | Educational pack   | 1                    | IND            | W               | HE                   | None                                       |
| <b>Miscellaneous</b>  |                 |  |                      |                |                 |                      |  |
| Ansell et al, <sup>89</sup> 1995  | No              | 2  | 2                    | IND            | F, T            | RN                   | None                                       |
| Clark et al, <sup>90</sup> 1992   | Yes             | 4  | 4                    | GP             | F, V            | HE                   | SCT  |
| de Wit et al, <sup>91</sup> 1997  | Yes             | Individual inpatient session, educational pack, diary, and video | 1                    | IND            | F, T, A         | RN                   | SCT  |
| Oldenburg et al, <sup>92</sup> 1995   | Yes             | 8  | 52                   | GP             | F               | RN, PT, MH           | SCT  |
| Sawicki, <sup>93</sup> 1999   | Yes             | 3  | 3                    | GP             | F, T            | RN, MD               | SCT  |

Abbreviations: A, audiocassettes; CBT, cognitive behavioral therapy; F, face-to-face contact; GP, group sessions; HE, health educators; IND, individual sessions; LE, lay educators; MD, physicians; MH, mental health workers; NA, not applicable or not available; OT, occupational therapists; PT, physical therapists; RD, registered dietitians; RN, registered nurses; RT, reality therapy; SCT, social cognitive therapy; T, telephone contacts; V, video programming; W, written materials.

\*The primary mode of education is listed first.

†The primary program facilitator is listed first.

programs for selected chronic diseases. We found that the methods for conducting such trials were suboptimal. Calculations of summary random- and fixed-effects size indicate that these programs yield only small to moderate benefit in interventions for diabetic patients and patients with hypertension. These statistically significant effects might be compared with dietary sodium restriction for patients with hypertension.<sup>94</sup> Frequency of asthma attacks was also reduced with self-

management education when count data were included. However, the magnitude of reduction was much smaller than a standard treatment for asthma such as oral corticosteroids.<sup>95</sup> We found no significant improvement associated with self-management educational interventions for arthritis. In a metaregression, we found that interventions involving face-to-face contact were associated with better outcomes; no other trial characteristics were associated with improved outcomes. A fun-

nel plot for all trials suggested the presence of bias against publishing negative or null trials.

We found that the methodology used in conducting and reporting trials of self-management education programs varied widely. The lack of standard methods may hinder interpretation of summary data across diseases and programs, such as ours. Although some would suggest that this heterogeneity precludes a meta-analysis, we believe that these programs are much more similar than different and that an attempt to summarize the findings quantitatively is valuable. We applied rigorous inclusion and exclusion criteria to limit the heterogeneity of patient populations and interventions. By reducing the heterogeneity of studies, we may have limited the number of studies with extreme results. We were interested to see whether common aspects of programs across diseases were associated with the effect sizes. We found that interventions that incorporated face-to-face education were more effective; this observation should be considered when developing future educational programs.

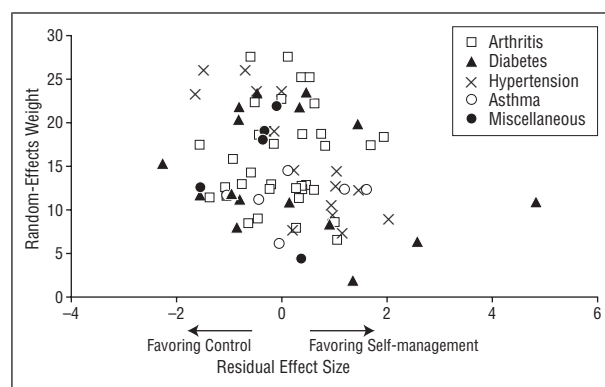
We had hypothesized that self-management education may be effective only for certain chronic diseases, and our results support that conjecture. Self-management education had small to moderate benefit on important intermediate end points (glycosylated hemoglobin levels and systolic blood pressure) for diabetes and hypertension. These are 2 diseases in which patients can be taught the goals of therapy, such as optimizing fasting blood glucose levels and blood pressure, and effective means of achieving these goals, such as compliance with the medication regimen and diet. In addition, patients can learn to monitor these outcomes in an objective fashion. Patients with asthma can also be taught to monitor disease activity and adjust therapy using the peak flow meter; results for the asthma trials that include the count data suggest a benefit. However, the pooled effects of arthritis self-management education interventions did not suggest a significant benefit. One previous meta-analysis focusing on arthritis found small benefits but did not account for heterogeneity between studies.<sup>4</sup> One might imagine that the goals of arthritis self-management education are less easy to define than those of achieving an optimal fasting blood glucose level or blood pressure. Also, chronic diseases such as arthritis that may not respond fully to many treatments may be less affected by self-management education programs. Part of the rationale to combine studies across chronic diseases was to examine whether specific behavioral theories used in developing self-management education programs accounted for their success. Few researchers described an underlying behavioral science model, and programs that referenced a specific behavioral framework were not associated with better outcomes.

This structured review was limited partly by the difficulty in interpreting the included trials. Several important variables that might contribute to the success of an educational program were not accounted for in these analyses, because investigators rarely reported them. These include patient attributes such as educational level, disease duration, disease severity, social supports, and the level of confidence in one's ability to perform self-management (self-efficacy). Self-management education programs might be more effective in specific pa-

**Table 3. Summary Statistics by Chronic Disease**

| Chronic Disease, End Point | No. of Studies | Total No. | Random-Effects Model Results |               |         |
|----------------------------|----------------|-----------|------------------------------|---------------|---------|
|                            |                |           | Summary ES                   | 95% CI        | P Value |
| Arthritis                  |                |           |                              |               |         |
| Pain                       | 16             | 3665      | 0.12                         | 0.00 to 0.24  | .06     |
| Disability                 | 12             | 3518      | 0.07                         | 0.00 to 0.15  | .05     |
| Asthma                     |                |           |                              |               |         |
| FEV <sub>1</sub>           | 3              | 242       | 0.26                         | -0.15 to 0.68 | .21     |
| FOA                        | 4              | 798       | 0.01                         | -0.19 to 0.22 | .89     |
| Diabetes                   |                |           |                              |               |         |
| HbA <sub>1c</sub>          | 13             | 2036      | 0.45                         | 0.17 to 0.74  | .002    |
| FBG                        | 4              | 943       | 0.11                         | -0.05 to 0.28 | .17     |
| Hypertension               |                |           |                              |               |         |
| SBP                        | 7              | 1606      | 0.20                         | 0.01 to 0.39  | .04     |
| DBP                        | 8              | 2002      | 0.10                         | -0.06 to 0.26 | .23     |

Abbreviations: CI, confidence interval; DBP, diastolic blood pressure; ES, effect size; FBG, fasting blood glucose level; FEV<sub>1</sub>, forced expiratory volume in 1 second; FOA, frequency of attack (continuous end point); HbA<sub>1c</sub>, glycosylated hemoglobin level; SBP, systolic blood pressure.



Funnel plot to assess potential for publication bias. Each study included in the meta-analysis (N=71) is represented on the graph.

tient subgroups. Thus, future studies that include information on specific patient subgroups might help to elucidate whether certain patients benefit more from these programs. In addition, the authors did not adequately describe medication effects. An interesting observation was the increased effect of self-management education programs in diabetic and hypertensive populations where self-management education is associated with improved medication compliance. This may suggest why there was a difference in the effect of self-management programs across chronic diseases.

## CONCLUSIONS

This structured review suggests that self-management education programs had small to moderate benefits for several but not all chronic illnesses. The methods of conducting and reporting these trials were heterogeneous, and there was evidence of publication bias. We propose that a statement based on the CONSORT (Consolidated Standards of Reporting Trials) recommendations<sup>96</sup> be developed for trials of self-management education programs. This would allow for a better assessment of the

value of such programs. In addition, to facilitate testing of programs by independent investigators, we propose to create an electronic clearinghouse for the descriptions of self-management educational programs. This would facilitate testing of interventions by investigators other than the developers of individual programs. While self-management education programs are conceptually appealing, and while there has been a growing interest in them as a means of empowering patients, improving outcomes, and reducing health care costs, the findings of this review suggest that not all self-management education programs for all diseases are effective.

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## REFERENCES

- Hoffman C, Rice D, Sung HY. Persons with chronic conditions: their prevalence and costs. *JAMA*. 1996;276:1473-1479.
- Lorig K, Holman H. Arthritis self-management studies: a twelve-year review. *Health Educ Q*. 1993;20:17-28.
- Bodenheimer T, Lorig K, Holman H, Grumbach K. Patient self-management of chronic disease in primary care. *JAMA*. 2002;288:2469-2475.
- Institute of Medicine Committee on Health Care in America. *Crossing the Quality Chasm: A New Health System for the 21st Century*. Washington, DC: National Academy Press, Institute of Medicine; 2001.
- Holroyd KA, Creer TL. *Self-management of Chronic Disease: Handbook of Clinical Interventions and Research*. Orlando, Fla: Academic Press Inc; 1986.
- Mullen PA, LaVillie EA, Biddle AK, Lorig K. Efficacy of psychological interventions on pain, depression, and disability in people with arthritis: a meta-analysis. *J Rheumatol*. 1987;14(suppl 15):33-39.
- Bernard-Bonnin A, Stachenko S, Bonin D, Charette C, Rousseau E. Self-management teaching programs and morbidity of pediatric asthma: a meta-analysis. *J Allergy Clin Immunol*. 1995;95:34-41.
- Mullen PD, Mains DA, Velez R. A meta-analysis of controlled trials of cardiac patient education. *Patient Educ Couns*. 1992;19:143-162.
- Brewin CR. Theoretical foundations of cognitive-behavior therapy for anxiety and depression. *Annu Rev Psychol*. 1996;47:33-57.
- Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev*. 1977;84:191-215.
- Hedges LV, Olkin I. *Statistical Methods for Meta-analysis*. Orlando, Fla: Academic Press Inc; 1985.
- Chinn S. A simple method for converting an odds ratio to effect size for use in meta-analysis. *Stat Med*. 2000;19:3127-3131.
- Hasselblad V, McCrory DC. Meta-analytic tools for decision making: a practical guide. *Med Decis Making*. 1995;15:81-96.
- Petitti DB. *Meta-analysis, Decision-Analysis and Cost-Effectiveness Analysis: Methods for Quantitative Synthesis in Medicine*. 2nd ed. New York, NY: Oxford University Press Inc; 2000.
- Zeger SL, Liang K-Y. Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*. 1986;42:121-130.
- Applebaum KA, Blanchard EB, Hickling EJ, Alfonso M. Cognitive behavioral treatment of a veteran population with moderate to severe rheumatoid arthritis. *Behav Ther*. 1988;19:489-502.
- Barlow JH, Wright CC. Knowledge in patients with rheumatoid arthritis: a longer term follow-up of a randomized controlled study of patient education leaflets. *Br J Rheumatol*. 1998;37:373-376.
- Barlow JH, Barefoot J. Group education for people with arthritis. *Patient Educ Couns*. 1996;27:257-267.
- Bradley LA, Young LD, Anderson KO, et al. Effects of psychological therapy on pain behavior of rheumatoid arthritis patients: treatment outcome and six-month followup. *Arthritis Rheum*. 1987;30:1105-1114.
- Burckhardt CS, Mannerkorpi K, Hedenberg L, Bjelle A. A randomized, controlled clinical trial of education and physical training for women with fibromyalgia. *J Rheumatol*. 1994;21:714-720.
- Cohen JL, Van Houten S, DeVellis RF, DeVellis BM. Evaluation of arthritis self-management courses led by laypersons and by professionals. *Arthritis Rheum*. 1986;29:388-393.
- Fries JF, Carey C, McShane DJ. Patient education in arthritis: randomized controlled trial of a mail-delivered program. *J Rheumatol*. 1997;24:1378-1383.
- Keefe FJ, Caldwell DS, Williams DA, et al. Pain coping skills training in the management of osteoarthritic knee pain, II: follow-up results. *Behav Ther*. 1990;21:435-447.
- Keefe FJ, Caldwell DS, Williams DA, et al. Pain coping skills training in the management of osteoarthritic knee pain: a comparative study. *Behav Ther*. 1990;21:49-62.
- Lindroth Y, Bauman A, Brooks PM, Priestley D. A 5-year follow-up of a controlled trial of an arthritic education programme. *Br J Rheumatol*. 1995;34:647-652.
- Lindroth Y, Bauman A, Barnes C, McCredie M, Brooks PM. A controlled evaluation of arthritis education. *Br J Rheumatol*. 1989;28:7-12.
- Lorig K, Seleznick M, Lubeck D, Ung E, Chastain RL, Holman HR. The beneficial outcomes of the arthritis self-management course are not adequately explained by behavior change. *Arthritis Rheum*. 1989;32:91-95.
- Lorig K, Lubeck D, Kraines G, Seleznick M, Holman HR. Outcomes of self-help education for patients with arthritis. *Arthritis Rheum*. 1985;28:680-685.
- Lorig K, Feigenbaum P, Regan C, Ung E, Chastain RL, Holman HR. Comparison of lay-taught and professional-taught arthritis self-management courses. *J Rheumatol*. 1986;13:763-767.
- Maggs FM, Jubbs RW, Kemm JR. Single-blind randomized controlled trial of an educational booklet for patients with chronic arthritis. *Br J Rheumatol*. 1996;35:775-777.
- Maisiak R, Austin J, Heck L. Health outcomes of two telephone interventions for patients with rheumatoid arthritis or osteoarthritis. *Arthritis Rheum*. 1996;39:1391-1399.
- Mazzuca SA, Brandt KD, Katz BP, Chambers M, Byrd D, Hanna M. Effects of self-care education on the health status of inner-city patients with osteoarthritis of the knee. *Arthritis Rheum*. 1997;40:1466-1474.
- Neuberger GB, Smith KV, Black SO, Hassanein R. Promoting self-care in clients with arthritis. *Arthritis Care Res*. 1993;6:141-148.
- Nicassio PM, Radojevic V, Weisman MH, et al. A comparison of behavioral and educational interventions for fibromyalgia. *J Rheumatol*. 1997;24:2000-2007.
- Parker JC, Frank RG, Beck NC, et al. Pain management in rheumatoid arthritis patients: a cognitive-behavioral approach. *Arthritis Rheum*. 1988;31:593-601.
- Radojevic V, Nicassio PM, Weisman MH. Behavioral intervention with and without family support for rheumatoid arthritis. *Behav Ther*. 1992;23:13-30.
- Riemsma RP, Taal E, Brus HL, Rasker JJ, Wiegman O. Coordinated individual education with an arthritis passport for patients with rheumatoid arthritis. *Arthritis Care Res*. 1997;10:238-249.
- Shearn MA, Fireman BH. Stress management and mutual support groups in rheumatoid arthritis. *Am J Med*. 1985;78:771-775.
- Simeoni E, Bauman A, Stenmark J, O'Brien J. Evaluation of a community arthritis program in Australia: dissemination of a developed program. *Arthritis Care Res*. 1995;8:102-107.
- Strauss GD, Spiegel JS, Daniels M, et al. Group therapies for rheumatoid arthritis: a controlled study of two approaches. *Arthritis Rheum*. 1986;29:1203-1209.
- Vlaeyen JW, Teeken-Gruben NJ, Goossens ME, et al. Cognitive-educational treatment of fibromyalgia: a randomized clinical trial, I: clinical effects. *J Rheumatol*. 1996;23:1237-1245.
- Weinberger M, Tierney WM, Booher P, Katz BP. Can the provision of information to patients with osteoarthritis improve functional status? a randomized controlled trial. *Arthritis Rheum*. 1989;32:1577-1583.
- Bailey WC, Richards JM Jr, Brooks CM, Soong S, Windsor RA, Manzella BA. A randomized trial to improve self-management practices of adults with asthma. *Arch Intern Med*. 1990;150:1664-1668.
- Bolton MB, Tilley BC, Kuder J, Reeves T, Schultz LR. The cost and effectiveness of an education program for adults who have asthma. *J Gen Intern Med*. 1991;6:401-407.
- Clark NM, Feldman CH, Evans D, Levison MJ, Wasilewski Y, Mellins RB. The impact of health education on frequency and cost of health care use by low income children with asthma. *J Allergy Clin Immunol*. 1986;78:108-115.
- Evans D, Clark NM, Feldman CH, et al. A school health education program for children with asthma aged 8-11 years. *Health Educ Q*. 1987;14:267-279.
- Fireman P, Friday GA, Gira C, Vierthaler WA, Michaels L. Teaching self-management skills to asthmatic children and their parents in an ambulatory care setting. *Pediatrics*. 1981;68:341-348.
- Ford ME, Havstad SI, Tilley BC, Bolton MB. Health outcomes among African American and Caucasian adults following a randomized trial of an asthma education program. *Ethn Health*. 1997;2:329-339.



49. Garrett J, Fenwick JM, Taylor G, Mitchell E, Stewart J, Rea H. Prospective controlled evaluation of the effect of a community based asthma education centre in a multiracial working class neighborhood. *Thorax*. 1994;49:976-983.
50. Hilton S, Sibbald B, Anderson HR, Freeling P. Controlled evaluation of the effects of patient education on asthma morbidity in general practice. *Lancet*. 1986; 1:26-29.
51. Ignacio-Garcia JM, Gonzalez-Santos P. Asthma self-management education program by home monitoring of peak expiratory flow. *Am J Respir Crit Care Med*. 1995;151:353-359.
52. Jones KP, Mullee MA, Middleton M, Chapman E, Holgate ST. Peak flow based asthma self-management: a randomized controlled study in general practice. *Thorax*. 1995;50:851-857.
53. Lahdensuo A, Haahtela T, Herrala J, et al. Randomized comparison of guided self management and traditional treatment of asthma over one year. *BMJ*. 1996; 312:748-752.
54. LeBaron S, Zeltzer LK, Ratner P, Kniker WT. A controlled study of education for improving compliance with cromolyn sodium (Intal): the importance of physician-patient communication. *Ann Allergy Asthma Immunol*. 1985;55:811-818.
55. Snyder SE, Winder JA, Creer TL. Development and evaluation of an adult asthma self-management program: Wheezers Anonymous. *J Asthma*. 1987;24:153-158.
56. Verver S, Poelman M, Bogels A, Chisholm SL, Dekker FW. Effects of instruction by practice assistants on inhaler technique and respiratory symptoms of patients: a controlled randomized videotaped intervention study. *Fam Pract*. 1996; 13:35-40.
57. Wilson SR, Scamagas P, German DF, et al. A controlled trial of two forms of self-management education for adults with asthma. *Am J Med*. 1993;94:564-576.
58. Yoon R, McKenzie DK, Bauman A, Miles DA. Controlled trial evaluation of an asthma education programme for adults. *Thorax*. 1993;48:1110-1116.
59. Anderson BJ, Wolf FM, Burkhart MT, Cornell RG, Bacon GE. Effects of peer-group intervention on metabolic control of adolescents with IDDM: randomized outpatient study. *Diabetes Care*. 1989;12:179-183.
60. Bloomgarden ZT, Karmally W, Metzger J, et al. Randomized, controlled trial of diabetic patient education: improved knowledge without improved metabolic status. *Diabetes Care*. 1987;10:263-272.
61. Falkenberg MG, Elwing BE, Goransson AM, Hellstrand BES, Riis UM. Problem oriented participatory education in the guidance of adults with non-insulin-treated type-II diabetes mellitus. *Scand J Prim Health Care*. 1986;4:157-164.
62. Gilden JL, Hendryx MS, Clar S, Casia C, Singh SP. Diabetes support groups improve health care of older diabetic patients. *J Am Geriatr Soc*. 1992;40:147-150.
63. Kaplan RM, Chadwick MW, Schimmel LE. Social learning intervention to promote metabolic control in type I diabetes mellitus: pilot experiment results. *Diabetes Care*. 1985;8:152-155.
64. Kaplan RM, Hartwell SL, Wilson DK, Wallace JP. Effects of diet and exercise interventions on control and quality of life in non-insulin-dependent diabetes mellitus. *J Gen Intern Med*. 1987;2:220-228.
65. Korhonen T, Huttunen JK, Aro A, et al. A controlled trial on the effects of patient education in the treatment of insulin-dependent diabetes. *Diabetes Care*. 1983; 6:256-261.
66. Kronsbein P, Jorgens V, Muhlhauser I, Scholz V, Venhaus A, Berger M. Evaluation of a structured treatment and teaching programme on non-insulin-dependent diabetes. *Lancet*. 1988;2:1407-1411.
67. Malone JM, Snyder M, Anderson G, Bernhard VM, Holloway Jr GA, Bunt TJ. Prevention of amputation by diabetic education. *Am J Surg*. 1989;158:520-524.
68. Mazza SA, Moorman NH, Wheeler ML, et al. The Diabetes Education Study: a controlled trial of the effects of diabetes patient education. *Diabetes Care*. 1986;9:1-10.
69. Muhlhauser I, Bruckner I, Berger M, et al. Evaluation of an intensified insulin treatment and teaching programme as routine management of type I (insulin dependent) diabetes. *Diabetologia*. 1987;30:681-690.
70. Raz I, Soskolne V, Stein P. Influence of small-group education sessions on glucose homeostasis in NIDDM. *Diabetes Care*. 1988;11:67-71.
71. Rettig BA, Shrauger DG, Recker RR, Gallagher TF, Wiltse H. A randomized study of the effects of a home diabetes education program. *Diabetes Care*. 1986;9: 173-178.
72. Starostina EG, Antsiferov M, Galstyan GR, et al. Effectiveness and cost-benefit analysis of intensive treatment and teaching programmes for type 1 (insulin-dependent) diabetes mellitus in Moscow—blood glucose versus urine glucose self-monitoring. *Diabetologia*. 1994;37:170-176.
73. Vinicor F, Cohen SJ, Mazza SA, et al. DIABEDS: a randomized controlled trial of the effects of physician and/or patient education on diabetes patient outcomes. *J Chron Dis*. 1987;40:345-356.
74. Wilson W, Pratt C. The impact of diabetes education and peer support upon weight and glycemic control of elderly persons with noninsulin dependent diabetes mellitus (NIDDM). *Am J Public Health*. 1987;77:634-635.
75. Cupples ME, McKnight M. Randomized controlled trial of health promotion in general practice for patients at high cardiovascular risk. *BMJ*. 1994;309:993-996.
76. Garcia-Vera MP, Labrador FJ, Sanz J. Stress-management training for essential hypertension: a controlled study. *Appl Psychophysiol Biofeedback*. 1997;22: 261-283.
77. Gonzalez-Fernandez RA, Rivera M, Torres D, Quiles J, Jackson A. Usefulness of a systemic hypertension in-hospital program. *Am J Cardiol*. 1990;65:1384-1386.
78. Iso H, Shimamoto T, Yokota K, Sankai T, Jacobs DR Jr, Komachi Y. Community-based education classes for hypertension control: a 1.5-year randomized controlled trial. *Hypertension*. 1996;27:968-974.
79. Martinez-Amenos A, Ferre LF, Vidal CM, Rocasalbas JA. Evaluation of two educative models in a primary care hypertension programme. *J Hum Hypertens*. 1990; 4:362-364.
80. Levine DM, Green LW, Deeds SG, Chwalow J, Russell RP, Finlay J. Health education for hypertensive patients. *JAMA*. 1979;241:1700-1703.
81. Morisky DE, Levine DM, Green LW, Smith C, Benson P, Finlay J. The relative impact of health education for low- and high-risk patients with hypertension. *Prev Med*. 1980;9:550-558.
82. Morisky DE, Bowler MH, Finlay JS. An educational and behavioral approach toward increasing patient activation in hypertension management. *J Community Health*. 1982;7:171-182.
83. Morisky DE, Levine DM, Green LW, Smith CR. Health education program effects on the management of hypertension in the elderly. *Arch Intern Med*. 1982;142: 1835-1838.
84. Morisky DE, Levine DM, Green LW, Shapiro S, Russell RP, Smith CR. Five-year blood pressure control and mortality following health education for hypertensive patients. *Am J Public Health*. 1983;73:153-162.
85. Muhlhauser I, Sawicki PT, Didjurgeit U, Jorgens V, Trampisch HJ, Berger M. Evaluation of a structured treatment and teaching programme on hypertension in a general practice. *Clin Exp Hypertens*. 1993;15:125-142.
86. Sawicki PT, Muhlhauser I, Didjurgeit U, Baumgartner A, Bender R, Berger M. Intensified antihypertensive therapy is associated with improved survival in type 1 diabetic patients with neuropathy. *J Hypertens*. 1995;13:933-938.
87. Stahl SM, Kelley CR, Neill PJ, Grim CE, Mamlin J. Effects of home blood pressure measurement on long-term BP control. *Am J Public Health*. 1984;74:704-709.
88. Watkins CJ, Papacosta AO, Chinn S, Martin J. A randomized controlled trial of an information booklet for hypertensive patients in general practice. *J R Coll Gen Pract*. 1987;37:548-550.
89. Ansell JE, Patel N, Ostrovsky D, Nozzoliolo E, Peterson AM, Fish L. Long-term patient self-management of oral anticoagulation. *Arch Intern Med*. 1995;155: 2185-2189.
90. Clark NM, Janz NK, Becker MH, et al. Impact of self-management education on the functional health status of older adults with heart disease. *Gerontologist*. 1992; 32:438-443.
91. de Wit R, Van Dam F, Zandbelt L, et al. A pain education program for chronic cancer patients: follow-up results from a randomized controlled trial. *Pain*. 1997; 73:55-69.
92. Oldenberg B, Martin A, Greenwood J, Bernstein L, Allan R. A controlled trial of a behavioral and educational intervention following coronary artery bypass surgery. *J Cardiopulm Rehabil*. 1995;15:39-46.
93. Sawicki PT. A structured teaching and self-management program for patients receiving oral anticoagulation: a randomized controlled trial. *JAMA*. 1999;281: 145-150.
94. Hooper L, Bartlett C, Davey Smith G, Ebrahim S. Reduced dietary salt for prevention of cardiovascular disease [Cochrane Review on CD-ROM]. Oxford, England: Cochrane Library, Update Software; September 1, 2003; issue 3.
95. Wood-Baker R, Walters EH, Gibson P. Oral corticosteroids for acute exacerbations of chronic obstructive pulmonary disease [Cochrane Review on CD-ROM]. Oxford, England: Cochrane Library, Update Software; September 1, 2003; issue 2.
96. Moher D, Schulz KF, Altman DG, for the CONSORT Group. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. *Ann Intern Med*. 2001;134:657-662.