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ORIGINAL ARTICLE

Social Support and Adherence to Treatment in Hypertensive Patients: A Meta-Analysis

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Abstract
Background It is important to examine factors associated with patient adherence to hypertension control strategies.
Purpose A meta-analysis was conducted to examine whether social support was related to adherence to healthy lifestyle and treatment medication in hypertensive patients.
Methods Journal articles were searched in medical (CINAHL, MEDLINE), psychological (PsycINFO, PsycARTICLES), and educational (ERIC) electronic databases; in reference lists of selected papers; and in the reference list of a previous review.
Results Findings of a set of meta-analyses indicated that (a) structural social support was not significantly related to overall adherence, (b) functional social support was significantly and positively related to overall adherence, (c) these findings were further confirmed in meta-analyses conducted on specific types of adherence, and (d) most results were characterized by heterogeneity across studies that was partially explained by moderator analyses.
Conclusions Functional social support, but not structural social support, was associated with adherence in hypertensive patients.

Keywords Adherence · Social support · Hypertension · Meta-analysis

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Background

Hypertension is a chronic condition affecting huge numbers of adults worldwide [1]. According to country-level indicators of the World Health Organization [2], in 2008, the percent of individuals with raised blood pressure (systolic blood pressure≥140 or diastolic blood pressure≥90) or on medication for raised blood pressure ranged from 25.8 to 55.5 % across countries. It has been estimated that in 2025 worldwide, adults affected by hypertension would be approximately 1.56 billion [3].

Hypertension is a well-known risk factor for stroke, myocardial infarction, heart, and renal failure [4]. Treatment of hypertension consists of lifestyle modifications (i.e., maintaining healthy diet, increasing physical exercise, and non-smoking) and/or pharmacological treatment [5]. However, high levels of patient non-adherence to hypertension control strategies (i.e., continuous monitoring of blood pressure), healthy behaviors, and medication are largely documented [6–9]. Adherence is significantly and positively correlated with patients' beliefs in the severity of the disease to be prevented or treated (i.e., disease threat [10]). Since hypertension is commonly asymptomatic, hypertensive patients are unlikely to follow the treatment because of discomfort or declining functioning [11].

Non-adherence has relevant negative outcomes, drastically hampering successful hypertension management [12]. Therefore, it is of utmost importance to individuate factors that can promote higher adherence [13]. A previous meta-analysis by DiMatteo [14] has highlighted that social support has a key role in promoting adherence to medical treatment. In this systematic review, the effects of different forms of social support were examined across a wide range of pathologies (e.g., asthma, cancer, cardiovascular diseases, cystic fibrosis, diabetes, HIV, renal diseases). Findings pointed out that the impact of social support on adherence ranged from small to medium.

Furthermore, the strength of the association between social support and adherence to treatment might be moderated by

several variables [14], related to the characteristics of the disease (e.g., type and seriousness), of the care regimen (e.g., life style recommendations and/or medication), of the patients (e.g., age, gender, ethnicity), and of the study methodology (e.g., types of measures employed for assessing social support and adherence). Therefore, to thoughtfully understand the role of social support in adherence, it is now essential to focus on specific diseases and to examine the impact of various moderators.

The Current Meta-Analytic Review

In line with this reasoning, the overall goal of our study was to summarize through a meta-analytic approach the literature on the association between social support and adherence to treatment in hypertensive patients. In order to advance our understanding of this topic, we focused on interconnections between specific dimensions of social support and specific dimensions of adherence. Furthermore, we tested whether and how moderators related to characteristics of hypertensive patients (i.e., age, gender, and ethnicity) and study designs (i.e., method used for assessing adherence)[1] could explain the differences in the strength of the association between support and adherence.

Dimensions of Social Support

So far, the literature has shown that social support plays a role in the etiology, the prognosis, and the management of a variety of physical health problems, including hypertension [5, 15, 16]. For instance, Carels et al. [17] found that chronic and acute blood pressure elevations were related to the quality of social support, and Hill and the collaborators [18] demonstrated that social support predicted a reduced risk for high blood pressure. Two main mechanisms can explain this pervasive impact of social support on health: the stress-buffering and main effect pathways [19]. According to the stress-buffering model, social support promotes health by providing psychological and material resources needed to cope with stress, while the main-effect model posits that social support has a beneficial effect on health since it endorses positive psychological resources (e.g., identity, purpose, self-worth, and emotion regulation) that induce health-promoting physiological and behavioral responses, irrespective of whether or not individuals experience a condition of stress [16]. More importantly, different dimensions of social support have been found to have distinct effects on health, highlighting a need to disentangle the specific pattern of associations between various dimensions of social support and health-related effects [18, 20, 21].

In this respect, various facets of social support can be conceptualized in terms of two broad domains: structural and functional social support [14, 15, 22, 23]. *Structural social support* refers to the structure of the social network surrounding an individual and it is mainly empirically operationalized as being married and living with somebody. *Functional social support* refers to the aid and encouragement that is provided to the individual by his/her social network and it can be empirically operationalized as emotional, instrumental, and informative social support. Structural social support has been found to have principally a main effect on health, whereas functional social support plays a more important role in stressful situations (buffering effect) [16, 22].

Thus, when individuals are in a condition of illness, functional social support might be more beneficial than structural social support. Evidence synthesized by DiMatteo [14] provided support to this hypothesis, highlighting that indicators of functional social support had stronger effects on patients' adherence than measures of structural support. Consistent with these considerations, in the current meta-analytic review, we also compared the effects of these two forms of social support, and in line with previous studies [14], we expected that functional social support would be more strongly related to adherence than structural social support.

Dimensions of Adherence

In this meta-analytic review, we examined the different dimensions of adherence. In fact, hypertensive patients are provided by their physicians with a number of recommendations that refer to adherence to pharmacological treatment (i.e., taking medications as often as prescribed and according to prescribed dosages), adherence to scheduled appointments, adherence to blood pressure monitoring, and/or adherence to healthy behaviors (i.e., doing physical activity, following a healthy diet, non-smoking). Up to now, a detailed comparative analysis of how different dimensions of social support are related to different dimensions of adherence is missing. Therefore, our purpose was to explore this issue, unraveling connections between support and specific adherence behaviors in observational studies, to examine the naturally occurring benefits of social support in hypertensive patients.

Method

Eligibility Criteria

Our literature search was aimed at identifying empirical quantitative studies on social support and adherence. We included all

[1] We hypothesized that two additional variables could moderate study results: complexity of drug regimen (i.e., operationalized as the mean number of prescribed drugs) and length of hypertensive diagnosis (i.e., defined as years from diagnosis). However, we could not proceed with testing these two moderators since most studies did not report this information.

the studies that matched the following eligibility criteria: (1) to report an indicator of structural (i.e., marital status and/or living arrangement) or functional social support (e.g., emotional, instrumental, health-related), (2) to report a measure of adherence to healthy behaviors (i.e., diet, physical activity, smoking status) and/or medication, and (3) to be focused on hypertensive patients. Exclusion criteria included studies reporting the results of interventions aimed to increase patient adherence. Further, the literature search was limited to articles published in peer-reviewed journals to enhance the methodological rigor of the studies examined and the conclusions drawn regarding the relationship between support and adherence. No a priori exclusion due to the publication language was done.

Search Strategies and Selection of Studies

We conducted the literature search in November 2012. We searched in psychological (PsycINFO, PsycARTICLES), educational (ERIC), and medical (CINAHL, MEDLINE) electronic databases all the references that included the terms ("support* or social* or famil* or marit* status* or living arrangement* or partner* or spouse* or caregiver* or relation*" in the abstract), ("hypertens*" in the title), and ("adherence or compliance or acceptance medical recommendation* or health* behavi* or health* life* style* or disease* manage*" in the abstract). Furthermore, we hand-searched in the references of the selected journal articles further relevant studies not initially found through the database search and we screened the references of a similar meta-analysis conducted on this topic [14].

We performed the selection process with a two-step approach. In a first step, the selection was based on titles and abstracts of the retrieved references. The selection process was conducted by the last author. Additionally, a trained rater evaluated independently a subsample of 500 references. We computed the percentage of agreement between the two raters to establish inter-rater reliability, which was found to be very high (95.2 %), and any discrepancies were resolved through discussion between the two raters. In the second step, the selected references were further screened by the last author in the full text to examine whether they matched the eligibility criteria.

Coding

A coding protocol was prepared and used to extract relevant information from the selected primary studies. In particular, six classes of information were coded: (a) characteristics of the publication (i.e., year and language of publication); (b) characteristics of the sample (i.e., total sample size; gender was coded as the percentage of women in a sample; age was coded as the mean, standard deviation, and age range of the sample in years; ethnic composition was coded as the percentage of members of ethnic or cultural minority groups in a sample; marital status was coded as the percentage of married persons in a sample; living arrangement was coded as the percentage of people living with somebody in a sample); (c) dimensions of social support (i.e., it was coded specifying if the study included a measure of structural and/or functional support; the provider of the information was coded as self-report or other-report); (d) dimensions of adherence (i.e., it was coded specifying which dimension of adherence was reported: adherence to medication, diet, physical activity, monitoring blood pressure, and/or non-smoking status; the provider of the information was coded as self-report or other-report); (e) information about the methodological design (i.e., the context of the study was coded as the country in which the research was conducted; the type of design was coded as cross-sectional or longitudinal); and (f) data necessary for effect size computations. Intra-rater reliability was established with the last author recoding all studies after 3 weeks from the first coding. Intra-rater reliability was very high (99.3 %).

Statistical Analyses

We synthetized study data using meta-analytic procedures. Statistical analyses were conducted with the meta-analytic software ProMeta 2.0. Initially, we computed Cohen's *d* (standardized mean difference) effect sizes from data reported in the articles (e.g., means and standard deviations; *p* values; correlations; odds ratios; etc.). When data for computing an effect size were not available in the articles, we contacted study authors for getting additional data. When results were reported as non-significant with no additional data available, we used the conservative approach of assigning an effect size equal to zero.

Positive values of the Cohen's *d* are indicative of a positive relationship between social support and adherence (i.e., married participants are more adherent than unmarried participants; individuals living with someone are more adherent than their counterparts living alone; people receiving high functional social support are more adherent than those receiving low support). According to Cohen's [24] criteria, *d*s<0.20 are considered small effects, *d*s of about 0.50 moderate effects, and *d*s of about 0.80 large effects. For each effect size, we also computed its 95 % confidence interval, variance, standard error, and statistical significance.

Effect sizes were pooled across studies for obtaining an overall effect size with the inverse-variance method. We used the random-effects model as a conservative approach to account for different sources of variation among studies (i.e., within-study variance and between-studies variance). Further, the random-effects model allows for generalization of the meta-analytic findings beyond the studies included in the current synthesis [25].

To examine heterogeneity across studies, we computed both Q and I^2 statistics [26]. A significant Q value indicates the lack

of homogeneity of results among studies. I^2 estimates the proportion of observed variance that reflects real differences in effect sizes, with values of 25, 50, and 75 % that might be considered as low, moderate, and high, respectively [27].

To further explain heterogeneity across study findings, we conducted moderator analyses. We tested three continuous moderators (i.e., mean age, % of women, and % of ethnic groups) by means of meta-regressions and one categorical moderator (i.e., method used to assess adherence) through subgroup analysis.

We conducted sensitivity analyses to check the stability of study findings, computing how the overall effect size would change removing one study at a time. Finally, we conducted publication bias analyses to control for the fact that published studies may have a larger mean effect size than unpublished studies [28]. We examined the funnel plot, which is a scatter plot of the effects sizes estimated from individual studies against a measure of their precision (e.g., their standard errors). In the absence of bias, the plot would be shaped as a symmetrical inverted funnel. However, since smaller or non-significant studies are less likely to be published, studies in the bottom left-hand corner of the plot are often omitted. To evaluate the funnel plot more reliably, we used two methods. First, we employed the Egger's regression method [29] to statistically test the asymmetry of the funnel plot, with non-significant results indicative of absence of publication bias. Second, we adopted the trim and fill procedure that is an iterative non-parametric statistical technique evaluating the effect of potential data censoring on the result of the meta-analyses [30]. In this method, the absence of publication bias is indicated by zero trimmed studies, or in the presence of trimmed studies, by trivial differences between the observed and the estimated effect sizes [31].

Results

Descriptive Characteristics of Studies Included in the Meta-Analysis

We found 32 journal articles that matched our eligibility criteria (more information about the selection process can be obtained from the last author upon request). One of these articles (Kemppainen et al. [32]) reported data from two independent samples (USA and Japan samples), and therefore, we analyzed a total of 33 studies. Main characteristics of selected studies are reported in Table 1. As can be seen, most articles were written in English, with only two studies published in other languages (i.e., Portuguese and Spanish); however, the context in which studies had been conducted was more heterogeneous, with 22 studies conducted in USA and 11 studies conducted in other countries around the world (i.e., Brazil, Canada, Finland, Greece, India, Japan, Kuwait, Malaysia, Mexico, UK). Sample sizes ranged from 41 to 5,095, with mean ages of participants comprised between 48 and 76 years. Thus, study samples included mainly middle adult and/or elderly patients. Most studies reported as an indicator of social support marital status, followed by functional social support (since measures of functional support varied across studies, we did not have enough studies for examining specific dimensions of functional social support, such as emotional and instrumental support, so we focused on overall functional support) and living arrangement (all social support measures were self-reports). Adherence to medication (with self- or other-reports) was the most common indicator of adherence. Other reported dimensions of adherence included physical activity, diet, non-smoking, appointment keeping behaviors, and blood pressure monitoring.

Associations Between Social Support and Adherence and Moderating Factors

We conducted three main meta-analyses examining the associations between overall adherence and the three types of support: living arrangement, marital status, and functional social support. Additionally, when at least three studies were available, in-depth relationships between social support and specific dimensions of adherence (e.g., adherence to medication) were further examined. Detailed results of a total of nine meta-analyses are reported in Table 2.

Living Arrangement and Adherence

We found a non-significant difference on adherence between hypertensive patients living with someone and those living alone in a highly heterogeneous set of studies (see Fig. 1 and Table 2).

Marital Status and Adherence

We found a non-significant difference on overall adherence between married and unmarried hypertensive patients in a moderately heterogeneous set of studies (see Fig. 2 and Table 2). This result was further confirmed by subsequent meta-analyses conducted on marital status and specific dimensions of adherence, such as adherence to medication, physical activity, diet, and non-smoking behaviors. Only a significant moderating effect was detected: the method used to assess adherence affected the strength of the association between marital status and overall adherence, Q (1)=7.68, $p<.01$. Specifically, the association between marital status and adherence was stronger in studies that employed other-informant measures of adherence, such as the pill-counting method (k=5, N=897, Cohen's d=.34 [.13, .54], $p<.01$), than in studies

Table 1 Study characteristics

Study name	Language of publication	Country	Sample size	% women	% ethnic minorities	Age M±SD (range)	% married/% living with somebody	Type of support[a]	Type of adherence and informant[b]
Al-Mehza et al. [33]	English	Kuwait	132	59.8	12.9	54±9.8	21.2/na	Marital status	Medication (O)[f]
Cavalari et al. [34] [c]	Portuguese	Brazil	75	52	14.7	61.5±10.36 (40–84)	70.7/na	Marital status	Medication (S)
Cummings et al. [35]	English	US	206	79	97 (Afro-American)	58 (≥18)	37/na	Marital status	Medication (S)
Gee et al. [36] [c]	English	Canada	5,095	53.3	13.3	66.82±12.35 (20–97)	42.08/na	Marital status	Medication (S)
Gohar et al. [37] [c]	English	UK	153	46.4	33.99	57.3±16	58.2/na	Marital status	Medication (S)
Hassan et al. [38]	English	Malaysia	240	49.8	12.1	54.5±8.49 (≥40)	92.8/na	Marital status	Medication (S)
Hershey et al. [39]	English	USA	132	60.61	91.67 (Afro-American)	52	Less than one half was married	Functional support (family support)	Medication (S)
Jones et al. [40]	English	USA	72	52.78	94.40 (Afro-American)	(≥18)	33.33	Marital status	Appointment-keeping behavior (O)
Joshi et al. [41]	English	India	139	40.29	na	55±10.9	86.33/na	Marital status	Medication (O)
Jung [42]	English	USA	52	92.31	na	Middle adults and elderly	na/na	Functional support (family/friend/ health-related support)	Multidimensional adherence (S)
Kemppainen et al. [32] (American sample)[c]	English	USA	105	57.1	70.5	56.90 (30–89)	49.5/80	Marital status	Physical activity/diet (S)
Kemppainen et al. [32] (Japanese sample)[c]	English	Japan	212	61.5	0.5	63.87 (30–90)	77/90	Marital status	Physical activity/diet (S)
Krousel-Wood et al. [43] [c]	English	USA	2,180	58.8	30.7	75±5.6 (≥65)	56.7/na	Marital status	Medication/smoking (S)
Krousel-Wood et al. [44] [cd]	English	USA	2,180	58.8	30.7	75±5.6 (≥65)	56.7/na	Functional support	Medication (S)
Kyngäs and Lahdenperä [45]	English	Finland	138	60	na	48 (20–62)	66.67/70	Marital status/living arrangement	Smoking (S)
Lancaster [46]	English	USA	592	85.3	24.2	76 (≥65)	14.9/na	Marital status/functional support	Diet (fruit/vegetables and low-fat dairy; S)
Li et al. [47] [c]	English	USA	144	47.92	100 (Chinese)	75.54 (65–91)	66.31/79.85	Marital status/functional support (health-related support)	Medication (S)
Lim et al. [48]	English	Malaysia	168	42	na	52 (30–75)	Na/97.62	Living arrangement	Medication (O)
Marin-Reyes and Rodriguez-Moran [49]	Spanish	Mexico	80	68.75	na	58.85±11.07	75/na	Functional support (family support)	Medication/physical activity/diet (S)
McLane et al. [50]	English	USA	62	74	0	73 (≥60)	Na/68.05	Living arrangement	Medication (S)
Morris et al. [51]	English	USA	492	73.2	68.3	56.6±10.8 (≥18)	21.1/na	Marital status/functional support	Medication (O)[g]
Ogedegbe et al. [52]	English	USA	153	85	100 (African American)	52±11.27 (>18)	18.3/na	Marital status	Appointment-keeping behavior (O)
Patel and Taylor [53]	English	USA	102	54.9	20	58.61±10.84	na/78.3	Living arrangement	Medication (S)
Schoenberg [54]	English	USA	41	60	100 (African American)	72±6.3 (65–89)	27/59	Living arrangement/f unctional support	Diet (S)
Schoenthaler et al. [55][c]	English	USA	439	68	100 (African American)	57.69±12.1 (25–98)	25/na	Marital status	Medication (S)
Schoenthaler et al. [56] [cd]	English	USA	167	85	100 (African American)	54±12.08 (≥18)	17.4/na	Marital status	Medication (S)
Shea et al. [57]	English	USA	202	59.44	100 (AfricanAmerican or Hispanic)	56.90±11.89 (24–78)	26.75/na	Marital status	Medication (S)
Stanton [58]	English	USA	50	44	6	58 (29–78)	76/na	Functional support (overall and health-related support)	Medication (O)[f]
Stavropoulou [59] [c]	English	Greece	743	60	na	61	81/na	Marital status	Medication (S)
Thorpe et al. [60]	English	USA	578	0	43.1	63.5±11.3	68.5/78.9		

Table 1 (continued)

Study name	Language of publication	Country	Sample size	% women	% ethnic minorities	Age M±SD (range)	% married/% living with somebody	Type of support[a]	Type of adherence and informant[b]
								Marital status/living arrangement	Blood pressure monitoring (possession and frequency) (S)
Trivedi et al. [61]	English	USA	636	66	51.6	61.25±12.32 (25–92)	50.47/na	Marital status	Medication/diet/physical activity/smoking (S)
Warren-Findlow et al. [62]	English	USA	188	71.3	100 (African American)	53 (22–88)	35.6/na	Marital status	Medication/diet/physical activity/smoking (S)
York Cornwell and Waite [11] [c]	English	USA	1,971	52.16	30.64	69.68±7.77 (57–85)	58.38/69.81	Marital status/living arrangement/ functional support (emotional/instrumental support)	Physical activity/smoking (S)

Note. na=not available

[a] Measures of support were all self-reported

[b] *S*=self-report, *O*=other report (e.g., pill count, administrative data)

[c] Data for effect size computations obtained from authors

[d] Longitudinal study, data for effect size computation selected from baseline

[e] Sample size includes diagnosed or undiagnosed hypertensive patients

[f] Authors used multiple measures of adherence but data for the effect size computation were based on the pill count

[g] The authors reported both self-reported and refill adherence. Effect sizes regarding the association between both measures of adherence and social support were similar. For our set of meta-analyses, we selected results based on refill adherence to increase the consistency of results based on other-informant methods. A series of sensitivity analyses indicated that this choice did not affect any of our meta-analytic results

Table 2 Summary of meta-analytic results

	k	*N*	Cohen's *d* [95 % CI]	*Q*	I^2	Egger	Trim and fill
Living arrangement—overall adherence	7	2,770	.07 [−.21, .34]	21.32**	71.85	−0.17	0
Marital status—overall adherence	24	14,627	.06 [−.01, .14]	47.33**	51.41	2.02	6 (.02 [−.07, .10])
Medication	16	11,119	.06 [−.04, .17]	43.64***	65.62	1.17	2 (.04 [−.07, .15])
Physical activity	5	3,021	.09 [−.00, .19]	5.45	26.58	0.71	2 (.04 [−.07, .15])
Diet	5	1,664	-.01 [−.18, .17]	6.79	41.07	0.42	0
Smoking	5	5,082	.09 [−.13, .32]	39.27***	89.81	0.59	2 (.05 [−.27, .17])
Functional support—overall adherence	10	5,659	.18** [.05, .31]	57.08***	84.23	2.61*	0
Medication	6	3,018	.24* [.03, .46]	50.91***	90.18	1.91	0
Diet	3	700	.38 [−.15, .92]	8.82*	77.33	0.57	0

Note. *k*=number of studies, *N*=total number of participants, Cohen's *d*=standardized mean difference, *CI*=confidence interval, *Q* and I^2 =heterogeneity statistics

*$p<.05$; **$p<.01$; ***$p<.001$

that used self-report assessments of adherence ($k=19$, $N=13{,}730$, Cohen's $d=.03$, [−.05, .10], *ns*).

Functional Support and Adherence

We found a significant small relationship between functional support and overall adherence in a highly heterogeneous set of studies (see Fig. 3 and Table 2). The strength of this link was further confirmed by additional meta-analyses conducted on two specific types of adherence (i.e., adherence to medication and diet). Furthermore, the association between functional support and adherence was moderated by the ethnic composition of the samples. This effect was statistically significant ($B=-.01$, $p<.05$) in the subset of studies relating functional support to adherence to medication and it was close to significance ($B=-.01$, $p=.052$) in studies focused on relationship between functional support and overall adherence. In both cases, the effect size was negatively related to the percentage of ethnic minority groups included in study samples, suggesting that the positive effects of social support lowered in sample consisting primarily of ethnic minority groups.

Sensitivity and Publication Bias Analyses

In each meta-analysis, sensitivity analyses indicated stability of meta-analytic findings. Furthermore, overall results of publication bias analyses conducted with the Egger's test and the trim and fill approach revealed that results were not affected by publication bias (see Table 2).

Discussion

In this meta-analytic review, we sought to unravel associations between social support and adherence to treatment in hypertensive patients. In order to gain a better understanding of this phenomenon we considered both structural (i.e., marital status and living arrangement) and functional social support and specific dimensions of adherence. The most important finding of our study is that functional social support but not structural social support was associated with adherence in patients with hypertension. In fact, this meta-analytic review highlighted that neither marital status nor living arrangement were significantly related to adherence, whereas functional social support was significantly associated with adherence. These results were further confirmed by additional meta-analyses conducted on specific dimensions of adherence, including adherence to medication, physical activity, diet, and non-smoking behaviors.

These findings are in line with our expectations and with prior literature. Indeed, DiMatteo [14] concluded her review on associations between support and adherence across a wide array of diseases stating that "the mere presence of other people does not matter as the quality of relationships with them" (p. 212). Our study contributes to the understanding of this phenomenon by adding an in-depth specific focus on this connection examined in hypertensive patients that have to deal with a chronic condition. Furthermore, we have confirmed this overall pattern of results considering both overall adherence as well as specific adherent behaviors related to both medication taking and healthy lifestyles.

Functional social support might increase adherence to treatment in several ways. Among the most common reasons of treatment non-compliance patients cite the lack of adequate information due to too short, and sometimes stressful, interactions with health care providers [63]. They also mention too general recommendations about lifestyle modifications received by their physicians [64]. In both cases, we could advance that "significant others" might buffer negative effects of unsatisfactory physician-patient relationships, proving hypertensive patients with meaningful information about treatment and concrete health modifications strategies.

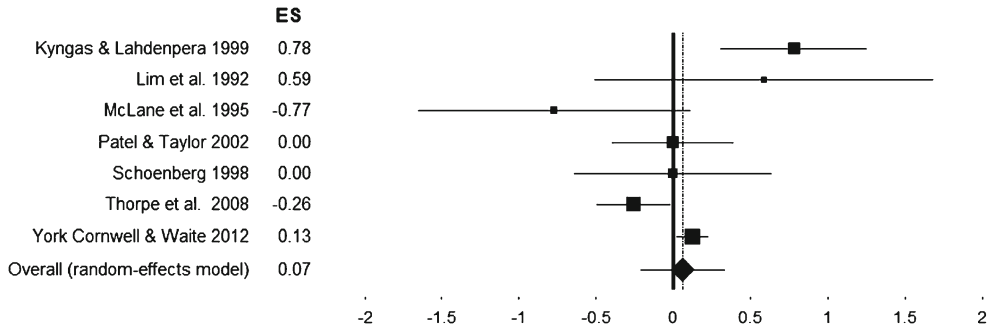

Fig. 1 Forest plot of effect sizes from the meta-analysis on living arrangement and overall adherence. *Error-bars* represent 95 % confidence intervals (CIs). The size of the square is proportional to the variance of the corresponding study; lower variances (i.e., larger sample sizes) are represented by *larger squares*

We have provided a further contribution to the literature by showing that some factors referring to characteristics of hypertensive patients moderate the strength of the association between support and adherence. Results indicated that the relationship between functional support and medication adherence was stronger in samples including lower percentage of ethnic minorities (this result was also replicated for overall adherence). This finding is consistent with considerations of various scholars [54, 65, 66] that have underlined that in ethnic minority groups social support might reduce adherence instead of promoting it, since family and friends may contradict physicians' recommendations by proposing alternative forms of treatment. Future studies are needed to further clarify the differential effects that ethnicity has on this phenomenon.

From a methodological point of view, we found that the method used to assess adherence was a moderator of the relationship between marital status and overall adherence. Specifically, we established that this relationship was stronger in studies in which researchers did not employ self-report measures of adherence but other methods, such as the pill counting method and the medication possession ratio. Usually, researchers are concerned about the fact that exclusively reliance on self-report measures may overestimate study findings [14]. Results of the current moderator analysis showed that this was not the case for the reviewed data; rather, the relationship between support and adherence in hypertensive patients was stronger when adherence was assessed by means of other-informant methods. So far, there is not a gold standard

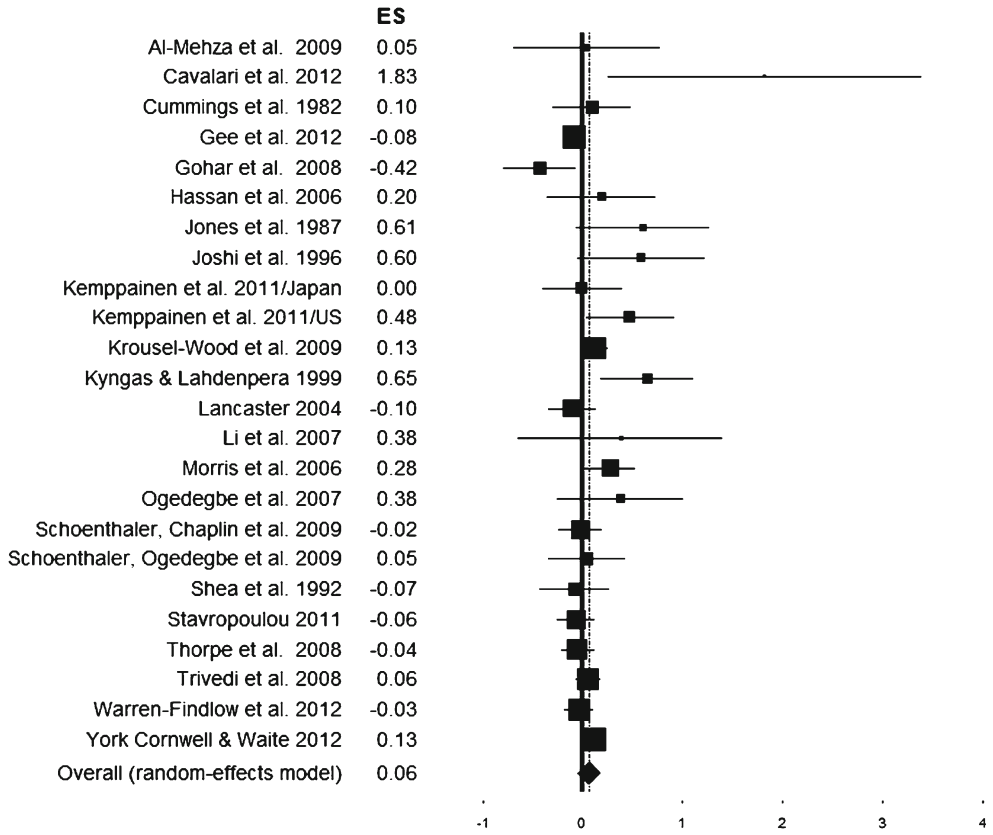

Fig. 2 Forest plot of effect sizes from the meta-analysis on marital status and overall adherence

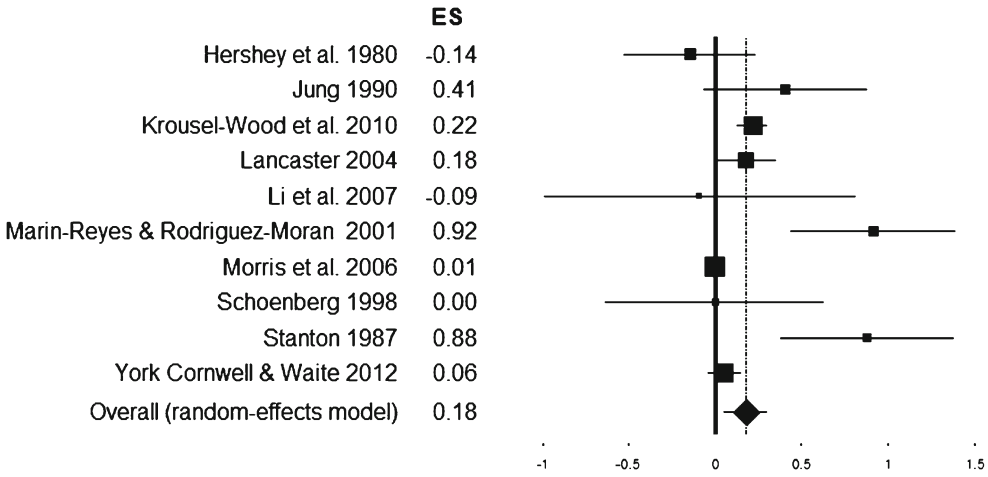

Fig. 3 Forest plot of effect sizes from the meta-analysis on functional support and overall adherence

for measuring adherence [61] and various scholars [51] underline the importance of relying on different methods for assessing it. When different instruments provide convergent levels of adherence, confidence about the actual patient's adherence increases. In contrast, when measures are inconsistent, further evaluations are needed to fully understand forms of suboptimal adherence.

Limitations of the Reviewed Literature and Suggestions for Future Research

The present meta-analytic review should be considered in light of some shortcomings. First, all studies included in this quantitative review, except for two [44, 56], were cross-sectional. Therefore, it was not possible to advance any causal inference about associations between support and adherence. Future studies should examine interconnections between social support, especially functional social support, and adherence with a longitudinal design in order to disentangle reciprocal relationships between these constructs. Doing so, it would be possible to test whether both baseline levels (i.e., intercepts) and changes over time (i.e., slopes) in social support are related to increasing levels of adherence to medication and healthy behaviors (e.g., transition from smoking to non-smoking status).

Second, most studies did not report detailed information about medication regimens (e.g., mean number of drugs) prescribed to patients and history of hypertension (e.g., years from diagnosis). Therefore, it was not possible to test whether these factors could moderate study findings. Future investigations should pay more attention at identifying high-risk situations in which social support might be more beneficial for dealing with a complex medication regimen and for facing adaptation to a new diagnosis of hypertension.

Third, definitions of structural social support (marital status and living arrangement) were consistent across studies whereas there was more variation in conceptualizations and measurements of functional social support. We did not have enough studies, and therefore enough statistical power, for comparing the effects of different conceptualizations of functional social support (e.g., emotional, informational, and instrumental support). Future studies could gain a better understanding of the role of social support by comparing effects of perceived support from key providers (e.g., family members, friends) on specific provisions (e.g., quality of information, emotional support, acceptance) [67].

Connected to the previous point, it should be added that available studies mainly focused on the presence or absence of support, whereas there was a dearth of investigations examining the degree of *satisfaction* for the received support. With this respect, it would be important to examine the perception of *loneliness*, which is defined as the distressing feeling that accompanies discrepancies between one's desired and actual social relationships. Number of relationships can be important, but perceived shortcomings in the quality of one's relationships are particularly closely linked to loneliness [68, 69]. Thus, future studies should analyze more in-depth both the structure and the quality of the social network of hypertensive patients. In this way, it could be possible to further unravel key dimensions of social support that have more benefits for adherence.

Finally, a main direction for future studies would involve disentangling interrelationships among social support, adherence, and another key factor related to both support and adherence that is depression/depressive symptoms. In fact, depression is related to poor relationships and feelings of social isolation and to non-adherence to medical treatment across a range of chronic diseases, including hypertension [70–74]. Importantly, Krousel-Wood et al. [44] found that at the univariate level both social support and depression were significantly related to adherence, whereas at the multivariate level (i.e., after controlling for their reciprocal effects) only depression remained a significant predictor of adherence. This result, showing that the link between social support and

adherence was attenuated and became non-significant after adjustment for depressive symptoms, was confirmed in both cross-sectional and longitudinal analyses. It may suggest that depression acts as a mediator of the relationship between social support and adherence. In this respect, poor social support may lead to increased depressive symptoms that lessen adherence [44]. Future investigations are needed to test this hypothesis and unravel the pathways linking social support and depression to adherence to hypertensive treatment.

Practical Implications

Adherence to treatment recommendations has a major impact on health outcomes and costs of care for hypertensive patients. Clinical trials have highlighted that the treatment of hypertension can reduce the risk of stroke by 30 to 43 % and of myocardial infarction by 15 % [9]. Thus, the development of interventions aimed at promoting adherence to antihypertensive treatment is a priority both to improve patients' quality of life and to reduce medical expenditures.

Findings of the current meta-analysis suggest that functional social support, but not structural social support, is related to adherence to treatment in hypertensive patients. However, the cross-sectional design of the majority of the articles included in this review prevents us from drawing definitive conclusions about the short-term and long-terms effects that this dimension of support can have on adherence. Future research is needed to explore whether interventions increasing functional social support received by hypertensive patients are effective in improving adherence to treatment.

Furthermore, in considering the practical implications of this meta-analysis, we must keep in mind that effect sizes were generally small. This leads to two considerations. First, it calls for the importance of distinguishing the effects that specific dimensions of support (e.g., instrumental, emotional, and informational) might have on adherence. As noted above, in the current meta-analysis, we did not have enough studies to disentangle the effects of various types of functional social support across multiple facets of adherence. Second, the small effect sizes detected in this meta-analysis were consistent with effect sizes reported in further meta-analyses analyzing other factors (e.g., depression [71]) associated with adherence. This suggests that various psychosocial factors that can influence adherence should not be considered in isolation; rather, they should be combined in integrative interventions to potentiate their beneficial effects. A similar conclusion was drawn by Morgado et al. [75], who found that almost all of the pharmacist interventions that were effective for enhancing blood pressure control and adherence to antihypertensive therapy were complex and included a combination of various strategies and procedures.

In conclusion, practical interventions finalized at improving adherence in order to achieve optimal blood pressure control should match the complexity of the adherence phenomenon, by targeting multiple factors that represent resources (e.g., functional social support) or barriers (e.g., depressive symptoms) for adherence to medication and/or to healthy lifestyles [5, 13]. Further research, especially Randomized Control Trials, in testing the efficacy and feasibility of tailored integrative interventions (for an example, cf. [12]) is warranted to better understand how to utilize/implement the available findings in meaningful ways. Achieving this goal is a priority both for enhancing individual well-being and for reducing the health care burden due to hypertension and its comorbidity.

Authors' Statement of Conflict of Interest and Adherence to Ethical Standards Authors Maria Elena Magrin, Marco D'Addario, Andrea Greco, Massimo Miglioretti, Marcello Sarini, Marta Scrignaro, Patrizia Steca, Luca Vecchio, and Elisabetta Crocetti declare that they have no conflict of interest.

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