The Relationship Between Social Support and Physiological Processes: A Review With Emphasis on Underlying Mechanisms and Implications for Health

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In this review, the authors examine the evidence linking social support to physiological processes and characterize the potential mechanisms responsible for these covariations. A review of 81 studies revealed that social support was reliably related to beneficial effects on aspects of the cardiovascular, endocrine, and immune systems. An analysis of potential mechanisms underlying these associations revealed that (a) potential health-related behaviors do not appear to be responsible for these associations; (b) stress-buffering effects operate in some studies; (c) familial sources of support may be important; and (d) emotional support appears to be at least 1 important dimension of social support. Recommendations and directions for future research include the importance of conceptualizing social support as a multidimensional construct, examination of potential mechanisms across levels of analyses, and attention to the physiological process of interest.

Social relationships are a ubiquitous part of life, serving important social, psychological, and behavioral functions across the lifespan. More important, both the quantity and quality of social relationships have been reliably related to morbidity and mortality (see reviews by Blazer, 1982; Broadhead et al., 1983; Cassell, 1976; Cobb, 1976; S. Cohen & Syme, 1985; and House, Landis, & Umberson, 1988). For instance, House et al. reviewed evidence from 6 large prospective studies indicating that mortality is higher among more socially isolated individuals. These associations hold even after inclusion of standard control variables such as age and initial health status. Indeed, House et al. summarized evidence showing that the association between social relationships and health is comparable with standard risk factors, including smoking, blood pressure, and physical activity.

An important issue concerns the potential mechanisms responsible for the epidemiologic links between social relationships and such long-term health consequences (S. Cohen, 1988; S. Cohen & Wills, 1985; Kiecolt-Glaser & Glaser, 1989). In the present review, we first examine the evidence linking the positive aspects of social relationships (i.e., social support) to physiological processes. We characterize these associations by examining the influence of social support on aspects of the cardiovascular, endocrine, and immune systems. The literature search was conducted using the ancestry approach and with PsycLIT (1974–1995) and Medline (1983–1995) by crossing the keywords social support, social networks, or social integration with cardiovascular, blood pressure, endocrine, or immune. Only studies whose researchers directly examined the association between social support and physiological function were included in this review. Based on this research, we examined potential mechanisms responsible for the associations between social support and physiological function (S. Cohen, 1988).

We summarize the research examining social support and physiological processes by using both qualitative and meta-analytic procedures. Major details regarding studies (e.g., type of support assessment and main findings) were first characterized and analyzed in tabular form. Based on this qualitative analysis, meta-analytic procedures were used primarily when (a) the pattern of results were equivocal and (b) there were a sufficient number of relatively homogeneous studies (e.g., similar paradigms) to reliably characterize the effects of interest. In addition, meta-analytic procedures were used to test specific hypotheses from our qualitative analyses. The meta-analysis was performed using a commercially available software package (Mullin, 1989) that provided detailed results regarding combined tests of significance levels, effect sizes, tests of variability regarding significance levels and effect sizes, and a fail-safe number. Results of the unweighted meta-analysis are reported, but analyses weighted by sample size were also performed and produced comparable results. To reduce the

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The fail-safe number represents the number of unpublished null studies that would be needed to overturn the conclusions found in the meta-analysis. Although there is no standard fail-safe number, Rosenthal (1984) suggests that $5k + 10$, where $k$ represents the number of retrieved studies, represents a reasonable tolerance level.
problem of nonindependence for studies with multiple assess-
ments of social support, results were first transformed within a
study to z scores, averaged, and then entered into the meta-anal-
ysis. Therefore, as recommended by Rosenthal (1984), only one
statistic was included from each study. Finally, when results were
reported as nonsignificant, a conservative significance level of .50
was used (Mullin, 1989).

One important source of heterogeneity in the literature on so-
ocial support and health revolves around the conceptualization and
measurement of support (Barrera, 1986; S. Cohen & Wills, 1985;
Heitzzmann & Kaplan, 1988; Orth-Gomer & Unden, 1987; Tardy,
1985; Winemiller, Mitchell, Sutliff, & Cline, 1993). In the present
review, we include diverse studies with both structural (e.g., social
network) and functional (e.g., emotional support) measures of so-
cial support. Structural measures of support assess the existence
and interconnection between various social relationships (e.g.,
number of siblings), whereas functional measures of support as-
semble the particular functions that social relationships may serve
(e.g., providing emotional or informational support). The un-
derlyng theme of these assessments is that they conceptually mea-
sure the potentially positive aspects of social relationships. This
diversity reflects, in part, the interest that social support has gener-
ated in different areas of inquiry (e.g., sociology, psychology, and
health). When the number of studies permitted it, we performed
focused comparisons between structural and functional measures
of support to examine if they are associated with quantitatively
different effects on physiological function (S. Cohen & Wills,
1985). In addition, when appropriate we discuss the implications
of both measures in research regarding social support, physiological
processes, and health.

Social Support and Physiological Processes

More than 18 years have passed since the seminal reviews by
Cassell (1976) and Cobb (1976) on the importance of social
relationships for health. These 2 reviews in particular have been
responsible for generating interest in social support and its rela-
tionship to psychological and physical well-being. Cobb focused
primarily on the stress-buffering effects of social support and
emphasized the informational value of social support processes
(e.g., that one is cared for and loved) in fostering coping and
adaptation. Similarly, Cassell viewed social relationships as po-
tentially buffering the individual from life stressors but further
emphasized the importance of physiological processes in medi-
ating the effects of social relationships:

The psychosocial processes thus can be envisaged as enhancing sus-
cceptibility to disease. The clinical manifestations of this enhanced
susceptibility will not be a function of the particular psychosocial
stressor, but of the physicochemical or microbiologic disease agents
harbored by the organism or to which the organism is exposed.
(Cassell, 1976, p. 109)

As suggested by Cassell, the associations between social support
and physical health have been found on such diverse health out-
comes (e.g., coronary heart disease, cancer, and infectious
illnesses) that there are probably multiple physiological path-
ways by which social support may influence disease states. In
this review, we focus on the cardiovascular, endocrine, and im-
mune systems as potential physiological pathways by which so-
cial support influences physical health.

Correlational Studies Examining the Association
Between Social Support and Cardiovascular Function

Of the 81 studies whose researchers examined social support
and physiological processes, 57 focused on aspects of cardiovas-
cular function. This emphasis is understandable considering
that cardiovascular disorders are still the leading cause of death
in the United States and that social support has been linked to
lower coronary heart disease (CHD) rates (House et al., 1988).
Conceptually, an examination of the relationship between so-
cial support and the cardiovascular system is important because
of its implications for both the development and maintenance of
CHD. For instance, the prognostic value of tonic arterial blood
pressure in predicting cardiovascular disorders is widely ac-
cepted (J. J. Smith & Kampine, 1990). Additionally, the reac-
tivity hypothesis suggests that increased cardiovascular reactiv-
ity to stress may be an important factor in the development of
vascular disorders (see Krantz & Manuck, 1984; Man-
uck, 1994; and Matthews et al., 1986).

Because of the relatively large number of studies examining
cardiovascular parameters, we now briefly review basic prin-
ciples of cardiovascular physiology. The cardiovascular system
is involved in the transport of oxygen and the removal of carbon
dioxide, a critical function for every cell and organ in the body
(see Larsen, Schneiderman, & Pasin, 1968; and J. J. Smith &
Kampine, 1990, for detailed reviews). The heart muscle gener-
ates the necessary force for the circulatory process. The vascula-
ture (i.e., arteries, veins, and capillaries) serves as the vehicle
for the pumping of the heart.

The most commonly used cardiovascular measures in this re-
view include heart rate, systolic blood pressure (SBP), and dia-
static blood pressure (DBP). Heart rate, a measure of cardiac
chronotropy, is usually expressed in beats per minute. It is
jointly determined by the sympathetic and parasympathetic
nervous systems: Sympathetic activation increases heart rate,
whereas parasympathetic activation decreases heart rate.

SBP and DBP are measures of the force of blood against the
arterial walls and are a function of both cardiac output and the
relative state of the vasculature. Because of the importance of
blood pressure in the transport of blood, it is normally a regu-
lated endpoint. SBP is associated with ventricular contraction
(i.e., systole) and therefore corresponds to the peak arterial
pressure. DBP is associated with ventricular relaxation (i.e.,
diastole) and corresponds to the lowest arterial pressure.

For purposes of this review, it is important to distinguish be-
tween tonic and phasic components of cardiovascular activity
(Cacioppo, Berntson, & Andersen, 1991). Tonic or basal levels
of cardiovascular activity provide information on the tonic
physiologic state of an individual. The correlational studies ex-
amining the association between social support and cardiovas-
cular function have focused primarily on tonic measures. The
phasic or reactivity components of cardiovascular activity refer
to momentary fluctuations from tonic levels. Recent laboratory
studies, reviewed later, have focused on the possibility that so-
cial support may reduce cardiovascular reactivity to acute psy-
chosocial stressors.
An important issue to consider is the psychometric properties of the physiological assessments because they bear on the potential mechanisms linking social support to long-term physical health. In this regard, it is conceptually important to distinguish between measurement reliability and temporal stability. Measurement reliability refers to the accurate assessment of the physiological state at one point in time. In comparison, temporal stability refers to a dispositional characterization of physiological function (i.e., stability of the physiological assessment across different situations and occasions). Adequate measurement reliability is necessary but not sufficient for temporal stability. The distinction between measurement reliability and temporal stability is important because if social support is to have effects on disease processes with a long-term etiology, the physiological assessments should be characterized by temporal stability. The assessment context (e.g., specific tasks), population (e.g., phobics), and techniques (e.g., specificity of tracers in radioimmunoassay) may all influence an individual difference assessment of physiological function. As an example, a needle stick is often associated with relatively short-term elevations in catecholamines. Because of the measurement reliability of current techniques (Baum & Grunberg, 1995), the catecholamine changes due to venipuncture would be accurately assessed at that point in time. However, this may be a poor index of an individual’s catecholamine response across time and situations.

Past researchers have examined the temporal stability of heart rate, SBP, and DBP reactivity. As reviewed by Manuck, Kasprzak, Monroe, Larkin, and Kaplan (1989), measures of heart rate reactivity evidence the strongest test–retest correlation, typically ranging from .67 to .91. SBP reactivity tends to evidence adequate temporal stability that is slightly lower than the stability seen for heart rate, whereas DBP tends to show relatively low test–retest stability. Although many of the studies reviewed by Manuck et al. did not report data on the test–retest stability of tonic measures, the patterns of stability across heart rate, SBP, and DBP appear similar to that for reactivity assessments. It should be noted, however, that researchers have demonstrated that the stability of these cardiovascular assessments, including DBP, are enhanced considerably when assessments are aggregated across multiple time points and multiple tasks (Kamarck, 1992; Kamarck et al., 1992; Manuck, 1994).

There are several methodological issues related to an examination of the relationship between social support and cardiovascular function. In particular, the use of appropriate statistical controls is important as many of the studies reviewed in this section are correlational studies in which potential associations with confounding variables may occur. For instance, social support may be correlated with socioeconomic status, medication use, age, and other factors that may have direct influences on physiological function. We should note that there is some discrepancy in the literature on whether such variables are potential confounding variables or mechanisms by which social support has an association with health (S. Cohen, 1988; House et al., 1988). In our tabular analyses of each study, we explicitly note when such statistical controls were used. In addition, we discuss the attention (or lack thereof) paid to appropriate statistical controls and its implications for the mechanisms underlying the relationships between social support and cardiovascular function.

Many of the studies on social support and cardiovascular function have used a correlational design with normotensive individuals. Table 1 summarizes 28 correlational studies, most of which used middle-aged and older adult samples from the community. Twenty studies examined both men and women, 5 examined only men, 2 examined only women, and 1 study did not report the gender composition of the sample. Researchers of 14 of these studies explicitly assessed some aspect of familial support. In addition, researchers of 7 studies assessed structural measures of support, of 15 studies assessed functional measures of support, and of 6 studies assessed both structural and functional measures of support.

In general, the results of the correlational studies are consistent with the notion that higher social support is associated with better cardiovascular regulation (e.g., lower blood pressure). In 4 of the first studies investigating the relationship between social support and cardiovascular function, Kasl and Cobb (1980) examined the influence of social support on blood pressure changes in response to job termination; they reported that perceptions of social support were negatively related to blood pressure changes in response to job loss. To summarize Table 1, researchers of 23 studies reported some evidence that social support was associated with better cardiovascular function, of 4 studies reported no relationship (see Ely & Mostard, 1986; Houben, Diedriks, Kant, & Notermans, 1990; Kaufmann & Beehr, 1986; and Lercher, Hortnagl, & Kofler, 1993), and of 1 reported opposite effects (Hansell, 1985). A meta-analysis of 21 correlational studies whose researchers reported data on the association between social support and blood pressure revealed a significant combined test ($z = 4.22, p = .00001, \text{fail-safe } n = 117.38$). The mean effect size ($r$) was .08, suggesting a small but reliable effect across studies. None of the tests of variability was significant ($p > .45$). Thus, the evidence for an association between social support and lower blood pressure levels appears reliable.

We coded each of the studies included in the meta-analysis as measuring structural or functional measures of support. Of the 6 studies that assessed both types of support, we were able to separate the effects in 4 of these studies. Therefore, data from 9 studies were identified as structural, and data from 14 studies

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2 The meta-analysis consisted of 21 studies that directly examined the association between social support and tonic blood pressure levels. In 2 cases, we averaged the results reported across 2 different published studies (i.e., Dressler, 1980, 1983; Janes, 1990; Janes & Pawson, 1986) because data were apparently reported on the same sample. In addition, the 5 studies examining job-related social support were excluded from this analysis because it had been identified a priori as a feature associated with inconsistent effects. In the text, we examine in detail potential reasons why job-related support may be associated with weak effects on blood pressure.

In our initial search, we excluded 2 studies examining the relationship between social support and blood pressure for methodological reasons (James, LaCroix, Kleinbaum, & Sirogatz, 1984; Orth-Gomer, Rosen gren, & Wilhelmsen, 1993). More specifically, these studies included participants on cardiovascular medication but did not account for this factor in reporting the association between social support and blood pressure.
were identified as functional measures of support. Focused comparisons between the structural and functional measures of support revealed no differences in significance level \((p = .29)\) or effect size \((p = .47)\). Although appropriate caution is warranted because of the small number of studies contrasted, these data are consistent with the larger literature, suggesting that both structural and functional measures of support predict beneficial effects on physical health. However, the specific psychological and behavioral mechanisms that contribute to these effects may differ for structural and functional measures (S. Cohen, 1988). We return to a discussion of such issues later in the review.

Researchers in 3 of the 4 studies that did not find any relationship between indices of social support and blood pressure regulation measured job-related social support (Houben et al., 1990; Kaufmann & Beehr, 1986; Lercher et al., 1993). However, Winnubst, Marcelissen, & Kleber (1982) and Unden, Orth-Gomer, & Elofsson (1991) also examined work-related social support and reported some effects on cardiovascular function. One potential reason for this discrepancy may be related to the psychometric properties of the measures of social support. For example, the Lercher et al. measure of social support was two dichotomous questions (also see Houben et al., 1990, which also contains two questions), whereas Winnubst et al.'s measure contained five questions and Unden et al.'s measure contained six questions. Although Kaufmann and Beehr did report high internal consistencies for their job-related social support measures \((.59 < \text{internal consistencies} < .88)\), they did not report data on the main effects of social support on blood pressure (only that the interaction between social support and job stress was nonsignificant).

It is also possible that job-related social support may not be related to blood pressure because these relationships are not as significant for the individual, at least compared with other sources of support. Consistent with this possibility, we review evidence later in this article indicating that familial sources of support appear to be associated with reliable effects on blood pressure regulation.

An issue of interest concerns potential gender differences in social support processes (Shumaker & Hill, 1991). In this regard, the studies in Table 1 generally suggest that social support predicts better cardiovascular regulation in both men and women. Many of the studies in Table 1 had the effects of gender statistically controlled. However, 8 out of the 20 studies whose researchers examined both men and women did report gender effects (Bland, Krogh, Winkelstein, & Trevisan, 1991; Cottington, Brock, House, & Hawthorne, 1985; Dressler, Grell, Gallagher, & Viteri, 1992; Dressler, Mata, Chavez, Viteri, & Gallagher, 1986; Jackson & Adams-Campbell, 1994; Janes, 1990; Linden, Chambers, Maurice, & Lenz, 1993; Livingston, Levine, & Moore, 1991). In an illustrative study, Janes examined both structural (i.e., social resources) and functional (i.e., instrumental) measures of support in Samoan men and women. Results revealed that both structural and functional aspects of support predicted lower blood pressure in men and women. However, subsequent analyses by gender revealed that social resources were a stronger predictor of blood pressure in men, whereas instrumental support was a stronger predictor of blood pressure in women (also see Henderson, Byrne, Duncan-Jones, Scott, & Adcock, 1980). Therefore, these data suggest that social support is important for both men and women but that specific types of social support may be important as a function of gender (e.g., Bland et al., 1991).

A noteworthy feature of Table 1 is the 8 studies whose researchers examined the association between social support and cardiovascular function in differing cultural contexts. For instance, research by Dressler and colleagues suggests that culturally important aspects of social support predict lower blood pressure levels (Dressler, 1980, 1983, 1991; Dressler, Mata, et al., 1986; Dressler, Santos, & Viteri, 1986; Dressler et al., 1992). In addition, Janes and colleagues (Janes, 1990; Janes & Pawson, 1986) have data indicating similar associations in Samoan culture. An important point of the data generated by these studies is an emphasis on the proper operationalization of social relationships within a specific cultural context. For instance, Dressler (1983) used historical-cultural analyses to argue that societal membership is an important facet of social relationships in West Indian culture. These cross-cultural data demonstrate the generality of the effects of social support in predicting blood pressure across differing cultural contexts.

Despite the consistency of the associations reported in Table 1, there are several important issues relating to these studies. Many of the studies in Table 1 have conceptualized social as a unidimensional construct and operationalized social support in terms of general levels of social integration or perceptions of support. Clearly, social support can be conceptualized as a multidimensional construct (S. Cohen & McKay, 1984; Cutrona & Russell, 1990), and specific dimensions of social support may be more effective when they meet the demands of related stressors (Cutrona & Russell, 1990). In addition, an examination of specific dimensions of social support may suggest more precise mechanisms through which social support influences health (Uchino, Cacioppo, Malarkey, Glaser, & Kiecolt-Glaser, 1995). To this point, researchers in only 4 studies of Table 1 have assessed multiple functional dimensions of social support (Hanson, Isackson, Janzon, Lindell, & Rastam, 1988; Kaufmann & Beehr, 1986; Knox, Theorell, Svensson, & Waller, 1985; Strogatz & James, 1986). In 1 study that examined two conceptually distinct functional aspects of social support, Strogatz and James found that lower tangible but not appraisal support was a significant predictor of increased hypertension (i.e., DBP > 90 mm/Hg, or current use of hypertensive medication), particularly in low income Black participants. These data are consistent with the notion that specific support components may be more effective when they meet the demands of related situations.

One concern in these correlational studies was the rarity in which psychometric data regarding the measurement of social support were reported. Only 11 studies made reference to the psychometric properties of their scale (e.g., factor analysis and internal consistency). Given the heterogeneity in which studies summarized in Table 1 have conceptualized and measured social support, the scales' psychometric properties are important to examine, especially for the less validated measures of support.

Relatedly, only researchers of 4 studies in Table 1 reported any data on the temporal stability of the cardiovascular assess-
Table 1  
**Social Support and Cardiovascular Function: Correlational Studies**

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment—condition</th>
<th>ANS assessment</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Kasl &amp; Cobb (1980)</td>
<td>Correlational with multiple physiological assessments Assessment period (anticipation of job loss, termination, 6 months post, 12 months post, and 24 months post) BS factor: employment group (terminatees and controls)</td>
<td>174 men (35–60)</td>
<td>Perceptions of social support primarily from wife but also from friends and relatives</td>
<td>SBP, DBP</td>
<td>Social support negatively associated with DBP change from anticipation to termination and from anticipation to reemployment Data not presented for SBP because of redundancy with DBP</td>
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<tr>
<td>Dressler (1980)</td>
<td>Correlational</td>
<td>44 West Indian men, 56 West Indian women (40–49)</td>
<td>Multiple matings: common offspring with 2 or more people Presence of siblings: 2 or more siblings in community Society membership: membership in friendly societies</td>
<td>SBP, DBP</td>
<td>Individuals low in multiple matings had higher SBP and DBP Low society membership individuals evidenced higher DBP No main effect for number of siblings, however, interaction between siblings and life stress indicated that those high in siblings and low in life stress had the lowest SBP and DBP</td>
</tr>
<tr>
<td>Winnubst et al. (1982)</td>
<td>Correlational</td>
<td>1,167 men, 79 women (M = 45)</td>
<td>Social support from coworkers and supervisors</td>
<td>SBP, DBP</td>
<td>No main effect of social support from supervisors and coworkers on SBP or DBP Social support from supervisor associated with lower SBP and DBP in those who felt anxious or depressed</td>
</tr>
<tr>
<td>Dressler (1983)</td>
<td>Correlational</td>
<td>44 West Indian men, 56 West Indian women (40–49)</td>
<td>Presence of outside conjugal relationships Number of siblings in the community Membership in a voluntary association</td>
<td>SBP, DBP</td>
<td>Total social support associated with lower DBP</td>
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<tr>
<td>Study</td>
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<tr>
<td>Stavig et al. (1984)</td>
<td>Correlational</td>
<td>414 Asian and Pacific Islanders from California Hypertension Survey</td>
<td>Social support: number of times person eats out per week, marriage, number of close friends, number of close relatives, religious affiliation, and widowed</td>
<td>Hypertension:</td>
<td>Analyses performed statistically controlling for age, sex, and relative body weight</td>
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<td></td>
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<td>Residence: number of adults in household</td>
<td>SBP &gt; 140 mm/Hg and DBP &gt; 90 mm/Hg</td>
<td></td>
<td>Number of times eating out per week, marriage, number of close friends, and a religious affiliation was associated with lower rates of hypertension.</td>
</tr>
<tr>
<td>Cottington et al. (1985)</td>
<td>Correlational</td>
<td>135 White nonhypertensive men and 149 White nonhypertensive women from the Michigan Statewide Blood Pressure Survey</td>
<td>Quality of Relationships Scale: overall rating of the quality of one's relationship with family and best friend</td>
<td>SBP, DBP</td>
<td>Analyses performed excluding diagnosed hypertensives Analyses performed excluding diagnosed hypertensives Nonhypertensive women with poorer social support evidenced marginally higher SBP (p = .07), even after statistical controls for age, alcohol consumption, cigarette habits, relative weight, and education</td>
</tr>
<tr>
<td>Hansell (1985)</td>
<td>Correlational</td>
<td>254 students in Grades 9 to 12</td>
<td>Network structure: friendship choices made, friendship choices received, status choices received, reciprocated friendship, unreciprocated friendships received, friends of friends made, friends of friends received, reciprocated friends of friends, choices between cliques, density of choices received, centrality, reachability, primary network role, broker network role, symbiotic network role, and isolate network role</td>
<td>SBP, DBP</td>
<td>Analyses performed statistically controlling for sex, grade, SES, and achievement Analyses performed statistically controlling for sex, grade, SES, and achievement Reachability, primary network role, and broker network role associated with higher SBP Isolate network role associated with lower SBP</td>
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<tr>
<td>Knox et al. (1985; also in Table 5)</td>
<td>Correlational</td>
<td>56 hypertensive, 27 normotensive, 23 hypertensive men (M at initial testing = 28)</td>
<td>ISSI scale: number of contacts for different dimensions of social support (e.g., friendship and attachment)</td>
<td>HR, SBP, DBP</td>
<td>Excluded participants on medication Number of contacts averaged across different dimensions of social support negatively related to DBP Attachment and number of acquaintances associated with lower EPI in path model predicting SBP Number of contacts with acquaintances associated with lower HR in path model predicting DBP</td>
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<thead>
<tr>
<th>Study</th>
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<tr>
<td>Dresser, Mata, et al. (1986)</td>
<td>Correlational</td>
<td>65 Mexican men, 82 Mexican women</td>
<td>Perceived social support from relatives and neighbors during six problem situations (i.e., feeling nervous or upset, illness, debt, needing advice, and job difficulties). Social contact: frequency of interactions with others and number of voluntary associations one belongs to</td>
<td>SBP, DBP</td>
<td>Analyses performed statistically controlling for age, education, and occupational status. Perceived support from relative and perceived support from compadre negatively related to SBP and DBP in men. Perceived support from friend negatively related to SBP (but marginally with DBP) for men but positively related to DBP for women because primarily of relatively young women who evidence higher DBP as a function of perceived friend support, with the opposite trend in relatively older women. Perceived support from neighbors marginally associated with lower SBP and DBP for men. Social contact positively related to DBP for men. Controlling for age, sex, body mass, and SES revealed a Psychosocial Resources × Ethnicity interaction for SBP and DBP: low psychosocial resources associated with higher SBP and DBP for mixed–Black Brazilians than White Brazilians, whereas high psychosocial resources associated with equivalent SBP and DBP across ethnicity.</td>
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<tr>
<td>Dresser, Santos, et al. (1986)</td>
<td>Correlational BS factors: psychosocial resources (low and high), ethnicity (White and mixed–Black)</td>
<td>103 White and 25 mixed–Black Brazilians ($M = 33$)</td>
<td>Perceived social support from relatives and neighbors during six problem situations (i.e., feeling nervous or upset, illness, debt, needing advice, and job difficulties). Number of extended kin in the community. Psychosocial resources: with one or none of the resources listed above (or an active coping measure) were designated as low in psychosocial resources; with two or three were designated as high in psychosocial resources</td>
<td>SBP, DBP</td>
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<td>Ely &amp; Mostardi (1986; also in Table 5)</td>
<td>Correlational BS factors: group (police officers and controls) High LAI &gt; 100, low LAI &lt; 50</td>
<td>331 men (20–69)</td>
<td>Life Assets Inventory: combined index of self-perception, marital relationship, social support systems, and social resources from community and friends</td>
<td>HR, SBP, DBP</td>
<td>High social support (LAI) associated with lower NE than low social support</td>
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<td>Janes &amp; Pawson (1986)</td>
<td>Correlational</td>
<td>52 Samoan men, 42 Samoan women (18 to over 50)</td>
<td>Social support network: number of siblings in area, number of regularly visited relatives characterized by interaction and cooperation, and number of friends that they perceived to be especially close Composite social resources: church participation, size of social network, and frequency of weekly visits with relatives</td>
<td>SBP, DBP</td>
<td>Social support network associated with lower SBP and DBP for Samoan men and lower SBP for Samoan women, while statistically controlling for age and body mass Social Resources × Obesity interaction: Samoans with large body mass were characterized by a negative association between social resources and SBP and DBP, whereas no such association was evident in Samoans with small body mass</td>
</tr>
<tr>
<td>Kaufmann &amp; Beehr (1986)</td>
<td>Correlational</td>
<td>88 women ($M = 37$)</td>
<td>Social support: tangible and emotional support from supervisor, coworker, and extraorganizational sources Instrumental support to reduce workload</td>
<td>HR, SBP, DBP</td>
<td>In general, high social support associated with stronger stress-strain index (includes HR) relationship than low social support No interactions between social support and stress index for combined index of SBP and DBP</td>
</tr>
<tr>
<td>Strogatz &amp; James (1986)</td>
<td>Correlational</td>
<td>2,009 Blacks and Whites</td>
<td>Perceived tangible support and availability of advice (low or adequate)</td>
<td>Hyptensive: DBP &gt; 90 mm/Hg or current antihypertensive medication</td>
<td>Low tangible support associated with increased hypertension among both Blacks and Whites, however, statistical controls for age, sex, Age × Sex interaction, Quetelet index, education, family income, and alcoholic consumption eliminated the association between tangible support and the prevalence of hypertension for Whites but not Blacks The association between low tangible support and increased hypertension in Blacks primarily characteristic of low income Blacks</td>
</tr>
<tr>
<td>Hanson et al. (1988)</td>
<td>Correlational</td>
<td>500 men born in even months during 1914</td>
<td>Social network: social anchorage, contact frequency, social participation, and adequacy of social participation Perceived social support: availability of material and informational support, availability of emotional support, and adequacy of emotional support</td>
<td>SBP, DBP</td>
<td>Lower levels of social anchorage, availability of material and informational support, and adequacy of social participation associated with increased DBP Only social anchorage remained a significant predictor of lower SBP and DBP when statistically controlling for social class, marital status, arm circumference, medication status, alcohol consumption, smoking habits, physical activity, and body mass index</td>
</tr>
</tbody>
</table>

*(table continues)*
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment-condition</th>
<th>ANS assessment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houben et al. (1990)</td>
<td>Correlational</td>
<td>120 car mechanics ($M = 32$)</td>
<td>Perceived social support from supervisor or colleague: listen or help with work-related problems</td>
<td>SBP, DBP</td>
<td>Social support unrelated to SBP or DBP</td>
</tr>
<tr>
<td>Janes (1990)</td>
<td>Correlational</td>
<td>52 Samoan men, 42 Samoan women (18 to over 50)</td>
<td>Social resources: church attendance, close friends in area, friends visited more than once per month, number of visits with relatives (not siblings) in area, and number of siblings in area that you visit more than once per month Instrumental support: number of times in past year that friends or relatives helped with child minding, job and home searches, gone with you to see person in authority–non-Samoan, and how long lived with relatives before getting own place</td>
<td>SBP, DBP, MAP</td>
<td>Controlling for age and body mass revealed significant negative relationships between both social resources and instrumental support with both SBP and DBP Separate analyses by sex revealed that social resources negatively associated with SBP and DBP in men, whereas instrumental support negatively associated with SBP and DBP in women Follow-up analyses by sex revealed a Social Resources × Body Mass interaction for men: Large body mass was characterized by a negative association between social resources and MAP, whereas no such association was evident in Samoan men with small body mass Family Stressor × Instrumental Support interaction for women: High levels of family stress associated with strong negative association between instrumental support and MAP, whereas no association was evident in Samoan women at low levels of family stress Excluded participants on antihypertensive medication Statistical controls for age, body mass index, smoking, and education revealed that an aggregate measure of social network was negatively related to SBP and DBP for men and women Separate analyses of social network components revealed that the number of people in the household and participation in clubs and meetings were negatively related to SBP for men only, whereas number of siblings negatively related to SBP and DBP for women only</td>
</tr>
<tr>
<td>Bland et al. (1991)</td>
<td>Correlational</td>
<td>656 men, 753 women (20–70)</td>
<td>Social network: sum of number of members in household, number of siblings, number of clubs and meetings, religious service attendance, and marital status</td>
<td>SBP, DBP</td>
<td></td>
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</tbody>
</table>
Table 1 (continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment—condition</th>
<th>ANS assessment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dressler (1991)</td>
<td>Correlational</td>
<td>186 from a primarily Black community (sampled from 25–39 and 40–55)</td>
<td>Perceived familial and nonfamilial support in reaction to problems relating to discrimination, job, parents, parenting, marriage, finance, health, and personal</td>
<td>SBP, DBP</td>
<td>Analyses performed statistically controlling for age, sex, skin color, body mass index, hypertensive medication status, and reported awareness of hypertension Social Support Type × Lifestyle Incongruity × Age interaction for SBP and DBP: In younger participants, low nonkin support associated with increased SBP as a function of increasing lifestyle incongruity (i.e., extent to which an individual’s lifestyle is incongruent with his or her SES); in older participants, low kin support associated with increased SBP and DBP as a function of increasing lifestyle incongruity</td>
</tr>
<tr>
<td>Livingston et al.</td>
<td>Correlational</td>
<td>587 men, 833 women (18–60)</td>
<td>Social integration; marital status, group affiliation, church affiliation, and having someone to talk to in time of need</td>
<td>SBP, DBP</td>
<td>Never married associated with lower SBP for men and women and DBP for women than married or divorced Group affiliation associated with lower levels of SBP for men and women For women, church affiliation associated with higher SBP and supportive other associated with lower SBP and DBP Multivariate statistical model including age, education, income, hypertensive medication status, exercise, daily physical activity, alcohol intake, salt intake, cigarettes, body mass index, and the social integration indices revealed that (a) church affiliation predicted lower SBP for men and women and lower DBP for women and (b) marital status was associated with higher DBP for men Satisfaction with support associated with lower SBP Number of supportive relationships unrelated to SBP and DBP Analyses performed statistically controlling for age and sex Perceived social support at work negatively related to HR during sleep, work, and leisure time when also statistically controlling for physical strain and work control—demand Low perceived social support at work associated with higher resting SBP compared with high perceived social support</td>
</tr>
<tr>
<td>Malcolm &amp; Janisse</td>
<td>Correlational</td>
<td>64 men (30–54)</td>
<td>Social Support Questionnaire: perceived number of supportive relationships and satisfaction with support</td>
<td>SBP, DBP</td>
<td>(table continues)</td>
</tr>
<tr>
<td>Unden et al. (1991)</td>
<td>Correlational with multiple physiological assessments Assessment period (sleep, work, and leisure time)</td>
<td>117 working men, 31 working women (M = 40)</td>
<td>Perceived social support at work (i.e., good working environment, group cohesion, and quality of relationships among coworkers)</td>
<td>SBP, DBP, 24-hr ECG monitoring</td>
<td>(table continues)</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Participants (age, in years)</td>
<td>Social support assessment-condition</td>
<td>ANS assessment</td>
<td>Results</td>
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<tr>
<td>Dressler et al. (1992)</td>
<td>Correlational BS factor; SES (lower class, emergent-middle class, and middle-upper class)</td>
<td>73 African Jamaican men, 126 African Jamaican women (30 to 50)</td>
<td>Perceived social support from relatives, friends, neighbors, and church elders during six problem situations (i.e., feeling nervous or upset, illness, debt, needing advice, and job difficulties)</td>
<td>SBP, DBP</td>
<td>Analyses performed statistically controlling for age and body mass Church Elder Support × SES interaction for men on DBP: Low SES men evidenced a negative association between church elder support and DBP, whereas emergent-middle class and middle-upper class showed no association between church elder support and DBP Church elder support was associated with lower DBP for women regardless of SES Participants were medication free for 2 weeks prior to study Presence of family versus friends or strangers associated with lower SBP and DBP while seated Alone comparisons not significantly different than any other social situation for SBP or DBP</td>
</tr>
<tr>
<td>Spitzer et al. (1992)</td>
<td>Correlational with multiple physiological assessments Assessment period (every 20 min from 9 a.m. to 11 p.m.)</td>
<td>Mild to moderate hypertensives: 13 Black men, 17 White men, 11 Black women, 3 White women Normotensive: 25 Black men, 24 White men, 19 Black women, 19 White women (hypertensive M = 36, normotensive M = 34)</td>
<td>Social situation: alone, family, friends, and strangers at time of ambulatory cuff deflation</td>
<td>Ambulatory HR, SBP, DBP</td>
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</tr>
<tr>
<td>Lercher et al. (1993)</td>
<td>Correlational</td>
<td>74 men, 100 women (25–64)</td>
<td>Composite index of availability of coworkers as friends to do things with after work (yes, no) and help from supervisor with problems (yes, no)</td>
<td>SBP, DBP</td>
<td>Participants on antihypertensive medication excluded from analyses Statistical adjusting for age, body mass index, sex, education, smoking, and other occupational risks revealed no association with social support from work on SBP and DBP Preliminary analyses revealed social support unrelated to daily stress for men and women Social support associated with lower hostility in women Statistically controlling for age, obesity, and alcohol intake; social support associated with lower SBP for women</td>
</tr>
<tr>
<td>Linden et al. (1993)</td>
<td>Correlational with multiple physiological assessments Assessment period: 8- to 12-hr ambulatory monitoring</td>
<td>55 men, 74 women (M = 20)</td>
<td>Social support: perceived total support from up to eight people in one's network</td>
<td>SBP, DBP, HR</td>
<td></td>
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</tbody>
</table>
ments (Dressler, 1980, 1983; Hansell, 1985; Kaufman & Beehr, 1986). As a representative study, Dressler (1980) assessed SBP and DBP three times during the study, with each assessment separated by 20 min. Dressler reported strong average correlations between these readings ($r = .89$ for SBP, $r = .88$ for DBP) and thus evidence for temporal stability of the tonic assessments over relatively short periods of time. Nevertheless, the temporal stability of the physiological measures needs examination more consistently in correlational studies if social support is to be associated with the long-term development of CHD.

Finally, an important methodological issue for the studies summarized in Table 1 concerns the lack of explicit controls for cardiovascular-altering medications (e.g., beta blockers), especially because most of these studies tested middle-aged to older adult samples. Only 10 of the studies summarized in Table 1 directly reported that they had excluded individuals on cardiovascular medication or statistically controlled for this variable in their analyses. Researchers of 3 studies examined a young population in which medication use may not have been problematic. This issue is important because one might expect individuals low in social support to be characterized by higher blood pressure levels, however, the use of cardiovascular medications would serve to lower their blood pressure and eliminate or weaken the association between social support and tonic blood pressure levels. In fact, this may be one factor responsible for the relatively small, albeit reliable, meta-analytic association reported in this review. Future studies need to be sensitive to this potential confound.

### Intervention Studies Examining the Effects of Social Support on Cardiovascular Function

The evidence summarized in Table 1 suggests an association between social support and cardiovascular function. However, the correlational designs may limit the inferences from these studies. Table 2 summarizes 6 prospective intervention studies with normotensive middle-aged and older adult samples that examined social relationships and cardiovascular function. The social support interventions in these studies varied: 1 study provided opportunities for increased social interactions in activity groups, 2 studies used group discussions to increase social interactions, 1 study contained a social support education component, and 2 studies used social support to facilitate exercise, lifestyle, and stress management training. Two studies tested only women, 3 studies both men and women, and the remaining study did not report the gender composition of the sample.

Because of the small number of studies and the diverse ways in which social support was operationalized, we performed a qualitative analyses of the studies in Table 2. In this regard, researchers of 4 of the 6 studies in Table 2 reported positive effects of social support on cardiovascular function. In a prototypic investigation, Andersson (1985) studied older adults who reported problems with loneliness and randomly assigned them to either a small group discussion (e.g., opportunities for leisure activities) that met four times during the intervention or a condition of individuals followed for the duration of the study. A 6-month follow-up revealed that the support intervention participants had a greater frequency of social contact and
<table>
<thead>
<tr>
<th>Study</th>
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<th>Participants (age, in years)</th>
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</thead>
<tbody>
<tr>
<td>Arnetz et al. (1983; also in Table 5)</td>
<td>Prospective Assessment period (baseline, 3 months, and 6 months) BS factor: social interaction (social interaction and control)</td>
<td>Social interaction group: 10 men, 20 women ($M = 78$); control group: 10 men, 20 women ($M = 79$)</td>
<td>Social interaction group: participation in activity groups (e.g., music and botany) and social activities (e.g., picnics)</td>
<td>HR, SBP, DBP</td>
<td>Social interaction group reported engaging in more internal activities and increased attendance in outside organizational groups than the control group. Social interaction group showed less of a decline in testosterone over 6-month period compared with controls. Social interaction group had more increased DHEA at 3-month assessment than controls. Social interaction group evidenced greater increases in estradiol over 6-month period compared with controls. Social interaction group showed stable levels of growth hormones, whereas controls showed an increase over the 6-month period.</td>
</tr>
<tr>
<td>Gill et al. (1984)</td>
<td>Prospective Assessment period (preintervention and 3-month postintervention) BS factor: intervention group (control, support discussion, exercise, and support discussion-exercise)</td>
<td>50 women (40–65)</td>
<td>Support discussion group: weekly discussion for 2 hr of issues related to menopause and middle age (e.g., relationships with close family members) and development of new relationships Social Support Questionnaire: listed people they could count on for support and their satisfaction with the support they received Support intervention: small discussion groups meeting four times during intervention Social contact: frequency of contact with family members and close friends Social integration: single, divorced, widowed, number of years living alone, and number of children</td>
<td>HR, SBP, DBP, FVC, FEV, MVV, max HR during exercise</td>
<td>Discussion group (statistically partialing exercise effects) did not affect social support scores. Discussion group (statistically partialing exercise effects) was associated with larger decreases in resting FVC and greater max HR during stress testing.</td>
</tr>
<tr>
<td>Andersson (1985)</td>
<td>Prospective Assessment period (preintervention and 6-month postintervention) BS factor: intervention (support and control)</td>
<td>57 elderly women who reported problems with loneliness ($M = 77$)</td>
<td>Support intervention group reported greater frequency of social contact and leisure activities following intervention, whereas control group showed no such changes. Support intervention group was characterized by lower SBP and DBP following intervention even after controlling for baseline group differences (controlling for baseline levels revealed a marginal effect for DBP), sociodemography, childhood stability, work–life integration, and social integration, whereas control group showed no such changes. Within the support intervention group, opportunity for contact with grandparents during adolescence was associated with lower SBP and DBP changes after statistical controls for baseline levels but social integration measures unrelated to SBP and DBP changes after controlling for baseline levels</td>
<td>SBP, DBP</td>
<td>Support intervention group reported greater frequency of social contact and leisure activities following intervention, whereas control group showed no such changes. Support intervention group was characterized by lower SBP and DBP following intervention even after controlling for baseline group differences (controlling for baseline levels revealed a marginal effect for DBP), sociodemography, childhood stability, work–life integration, and social integration, whereas control group showed no such changes. Within the support intervention group, opportunity for contact with grandparents during adolescence was associated with lower SBP and DBP changes after statistical controls for baseline levels but social integration measures unrelated to SBP and DBP changes after controlling for baseline levels.</td>
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Table 2 (continued)

<table>
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<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment—condition</th>
<th>ANS assessment</th>
<th>Results</th>
</tr>
</thead>
</table>
| Sallis et al. (1987)| Prospective Assessment period (preintervention, postintervention, and 3-month follow-up); WS factor: epoch period (pretask baseline, mental arithmetic, pretask baseline, and cold pressor); BS factor: intervention group (support education, relaxation training, and multicomponent stress management) | 43 men, 33 women (M = 36) | Support intervention: education of the harmful effects of stress and the benefits of talking to someone and importance of group support sessions (8-10 weekly 1-hr meetings) | SBP, DBP       | Social support intervention rated significantly higher on educational info and importance of social support than relaxation training and multicomponent stress management interventions  
Social support and relaxation training intervention had smaller increases in DBP during preintervention to follow-up and lower DBP levels during recovery from the cold pressure compared with the multicomponent stress management intervention |
| Clifford et al. (1991) | Prospective Assessment period (preintervention, 3-month midtreatment, 6-month posttreatment, and 6-month follow-up); BS factor: intervention group (self-directed change, self-directed change with professional support, self-directed change with peer support, and control group) | 48                           | Self-directed change with professional support; exercise, lifestyle, and stress management training and an additional five individual sessions with a therapist  
Self-directed change with peer support: exercise, lifestyle, and stress management training and an additional five individual sessions with a group peer  
MBHI (Scale E): social alienation | SBP, DBP, VO₂ max | Pooled self-directed change groups with support were associated with lower SBP and DBP and higher VO₂ max at posttreatment and follow-up than control group  
Self-directed change group with peer support had poorer individual session attendance  
Social alienation scores unaffected by intervention and unrelated to posttreatment DBP |
| Hoff & Lowenstein (1994) | Prospective Assessment period (baseline, Week 9, and Week 21) | 6 men, 33 women (55 to 92) | Professional and peer support for educational risk reduction program (e.g., nutrition, exercise, and stress) during intervention sessions (Weeks 2–7) and follow-up (Weeks 10–20) | DBP            | Intervention program associated with decreased DBP at Week 21  
Authors noted that participants used the health care professionals to validate their plans for positive health care |

Note. None of the studies included an immune assessment, and only one (Arnett et al., 1983) included an endocrine assessment (main endocrine measures: cortisol, DHEA, estrogen, growth hormone, prolactin, testosterone, TSH, thyroxine, triiodothyronine, and creatinine. ANS = autonomic nervous system; BS = between subjects; DBP = diastolic blood pressure; DHEA = dehydroepiandrosterone; FEV = forced expired volume; FVC = forced vital capacity; HR = heart rate; max = maximum; MBHI = Million Behavioral Health Inventory; MVV = maximum voluntary ventilation; SBP = systolic blood pressure; TSH = thyroid stimulating hormone; VO₂ = volume of oxygen; WS = within subject.)
leisure activities and, more important, lower SBP and DBP. The control condition evidenced no such changes.

Only researchers of 2 of the studies conducted to date reported no effect of a social support intervention on blood pressure regulation (Arnetz, Theorell, Levi, Kallner, & Eneroth, 1983; Gill, Veigl, Shuster, & Notelevitz, 1984). However, Gill et al. did not find a significant manipulation check on social support, which suggests that the intervention was unsuccessful in affecting participants' support networks. The null finding by Arnetz et al. is more difficult to explain. However, familial relationships may be relatively important for blood pressure regulation (see Potential Mechanisms). In general, stronger associations might be obtained with interventions that focus on familial sources of support.

Although the studies summarized in Tables 1 and 2 suggest that social support influences cardiovascular function, few of these studies suggested its effect on established risk factors. To this point, we summarize 8 prospective (primarily intervention) studies with hypertensive patients in Table 3. Researchers of 5 of the 8 studies in Table 3 explicitly noted that they examined both White and Black participants. Researchers of 6 studies examined both men and women, whereas of 2 studies examined only men. Six of the interventions used for the most part familial sources of support. However, researchers of 1 study simply assessed naturalistic social support, and of 1 study used organizational social support.

Evidence for the role of social support on cardiovascular function and risk factors comes from the prospective intervention studies on hypertensive individuals summarized in Table 3. In an early study, Levine et al. (1979) identified 400 hypertensive patients and assigned them to interventions consisting of an exit interview, family support, small group, various combinations of these groups (e.g., exit interview and family support), or a control condition. In the family support condition, patients were asked to identify a target individual with whom they had frequent contact (typically a spouse). The target individuals were then trained to increase understanding, support, and reinforcement regarding positive management of the patient's hypertensive state. Results revealed that family support alone decreased DBP (i.e., DBP was below the hypertensive limits for the participant's particular age group) by 11% at an 18-month follow-up assessment. Predictably, exposure to all intervention conditions was associated with the best blood pressure control (28%). Subsequent follow-ups of this project sample revealed reliable long-term effects of the social support manipulation on blood pressure regulation (Morisky, DeMuth, Field-Fass, Green, & Levine, 1985; Morisky et al., 1983). A meta-analysis of studies whose researchers have used social support manipulations to control blood pressure in at-risk populations (Earp, Ory, & Sroogatz, 1982; Erfurt, Foote, & Heirich, 1991; Levine et al., 1979; Morisky et al., 1983, 1985; Stahl, Kelley, Neill, Grim & Mamin, 1984) revealed a significant combined test ($z = 3.32, p = 0.0004$, fail-safe $n = 12.29$). The mean effect size was $r = .15$, and no test of variability was significant ($p > .20$). These prospective data from at-risk populations provide evidence that social support may have beneficial effects on established risk factors.

Although the results of the prospective intervention studies with normotensives and hypertensives suggest that social support leads to better blood pressure regulation, there are several issues raised by these studies. The prospective intervention studies with hypertensives were primarily designed to affect tangible aspects of support. However, the social support manipulations may have affected other aspects of social support, including appraisal support due to the increased participation and knowledge of the support provider. Furthermore, although these studies suggest tangible support may have been important because of better medical adherence (e.g., Levine et al., 1979), none of the studies researchers performed statistical analyses to directly examine the importance of this factor. Interestingly, the prospective intervention studies generally preceded the correlational studies summarized in Table 1 that suggest tangible factors alone cannot explain the associations between social support and blood pressure regulation. Therefore, the prospective data are only suggestive of tangible support influences on blood pressure regulation because other unmeasured components of social support may have contributed to these effects.

We should also note that aspects of several interventions with normotensive participants might have affected other health-related processes (e.g., Andersson, 1985; Sallis, Trevorro, Johnson, Howell, & Kaplan, 1987). For instance, the Sallis et al. manipulation also informed participants of the harmful effects of stress (also see Clifford, Tan, & Gorsuch, 1991). Therefore, lifestyle or behavioral changes related to stress, but not directly involving social support, may have also contributed to the results of these studies. Nevertheless, the prospective design of the studies in Tables 2 and 3, along with the importance of blood pressure regulation in hypertensive individuals, provides relatively strong evidence linking social support to risk factors.

Potential Mechanisms Linking Social Support to Cardiovascular Function

Because of the consistency of the associations between social support and cardiovascular parameters presented in Tables 1 to 3, we now turn to specifying the potential mechanisms responsible for these covariations. In a review of potential mechanisms linking social support to health, S. Cohen (1988) suggests that social support may have beneficial effects through social (e.g., stress buffering), psychological (e.g., affective states), and behavioral (e.g., health-promoting) mechanisms. Consistent with S. Cohen (1988), we examined the mechanisms linking social support to physiological processes at different levels of analysis (also see Cacioppo & Berntson, 1992).

At a social psychological level of analysis, it appears that familial sources of social support may be associated with reliable effects on blood pressure regulation. A meta-analysis of 12 correlational studies whose researchers explicitly noted that they...
Table 3
Social Support and Cardiovascular Function: Studies With At-Risk Populations

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment/condition</th>
<th>ANS assessment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levine et al. (1979)</td>
<td>Prospective Assessment period (baseline and 18 months)</td>
<td>400 (91% Black, 70% women) hypertensive patients ($M = 54$)</td>
<td>Family support: individual with whom one has frequent contact with (usually a spouse) trained to increase understanding, support, and reinforcement</td>
<td>DBP</td>
<td>Family support was associated with attending a greater proportion of medical appointments than control group</td>
</tr>
<tr>
<td></td>
<td>BS factor: intervention group (control, exit interview, family support, small group, family support—small group, exit interview—family support, and exit interview—family support—small group)</td>
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<td></td>
<td>Family support alone increased DBP control by 11% (greater than exit interview alone but less than small group)</td>
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<td>Those exposed to all intervention groups showed best control of DBP (28% increase)</td>
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<tr>
<td>Earp et al. (1982)</td>
<td>Prospective Intervention period (baseline, 1 year, and 2 year)</td>
<td>218 predominately Black men and women with essential hypertension</td>
<td>Family support: individual with whom one has frequent contact with (usually a spouse) trained to increase understanding, support, and reinforcement</td>
<td>Uncontrolled hypertension: DBP $\geq 95$ mm/Hg</td>
<td>Standard home care with visits and significant other produced declines in uncontrolled hypertension during Years 1 and 2, whereas standard home care alone produced declines in uncontrolled hypertension in Year 1 but increases from Year 1 to Year 2</td>
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<tr>
<td></td>
<td>BS factor: intervention group (standard medical care, standard medical care and home visits from professionals, and standard home care and home visits as well as help from a significant other)</td>
<td></td>
<td></td>
<td></td>
<td>Results similar after statistical controls for provider setting, number of antihypertensive drugs at end of first year, race, education, age, and difficulty paying for care</td>
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<tr>
<td>Morisky et al. (1983)</td>
<td>Prospective Assessment period (baseline, 2 years, and 5 years)</td>
<td>400 (91% Black, 70% women) hypertensive patients ($M = 54$)</td>
<td>Family support: individual with whom one has frequent contact with (usually a spouse) trained to increase understanding, support, and reinforcement</td>
<td>DBP</td>
<td>Family support kept a greater proportion of their appointments at Years 2 and 5 than controls and had greater DBP control at Year 5 compared with controls</td>
</tr>
<tr>
<td></td>
<td>BS factor: intervention group (control, exit interview, family support, small group, family support—small group, exit interview—family support, and exit interview—family support—small group)</td>
<td></td>
<td></td>
<td></td>
<td>Family support—exit interview kept a greater proportion of their appointments at Year 2 and Year 5 than controls and showed better DBP control at Years 2 and 5 than controls</td>
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<td></td>
<td>Family support—small group and family support—exit interview—small group kept a greater proportion of their appointments at Year 5 than controls and showed greater control of DBP at Year 2 and 5 compared with control group</td>
</tr>
<tr>
<td>Stahl et al. (1984)</td>
<td>Prospective Assessment period (baseline, 0–6, 7–12, 13–18, 19–24, 25–30, and 31–36 months)</td>
<td>396 hypertensive patients, 58% women, 76% Black ($M = 47$)</td>
<td>Family support: significant other trained to take the patient’s blood pressure</td>
<td>DBP</td>
<td>Family support had a greater reduction in DBP at 0–6 month assessment than the control group, however, self support showed greater reductions than family support group and control group at 0–6 month assessment</td>
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<tr>
<td></td>
<td>BS factor: intervention group (family monitoring, self-monitoring, and control)</td>
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<td></td>
<td>No other group differences at other assessment periods, although patients in the family support group were less likely to drop out of study compared with the other two groups during the 3-year study</td>
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(table continues)
Table 3 (continued)

<table>
<thead>
<tr>
<th>Study</th>
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<tbody>
<tr>
<td>Pinto et al. (1985)</td>
<td>Prospective Intervention period (baseline and 12 months)</td>
<td>A chronic schizophrenic man (65) with uncontrolled hypertension over previous 6 months</td>
<td>Brother trained to give praise for taking medication, ignore refusal of medication, and reinforce after taking medication for a week</td>
<td>DBP</td>
<td>Following the intervention, DBP was within normal limits (DBP ≤ 90 mm/Hg)</td>
</tr>
<tr>
<td>Morisky et al. (1985)</td>
<td>Prospective Assessment period (baseline, 18–24, and 54–60 months) BS factor: intervention condition (family support component and no family support component)</td>
<td>400 hypertensive patients, 70% women, 90% Black (M = 54)</td>
<td>Family support: family members educated to assist the patient in controlling their blood pressure</td>
<td>SBP, DBP</td>
<td>Family support group had increased rates of continuation in program 5 years later, better medical compliance 2 years later, and better weight control 5 years later compared with no family support condition</td>
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<td>Family support group had better blood pressure control 5 years later and explained a significant portion of SBP and DBP variability at the end of the program compared with no family support group</td>
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<td>Health social support associated with increased compliance with hypertensive regime, but compliance not related to baseline or 3–6-month SBP and DBP</td>
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<td>No social support measure related to SBP or DBP at baseline or 3–6-month assessments</td>
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<tr>
<td>Jung (1990)</td>
<td>Prospective Assessment period (baseline and 3–6 months)</td>
<td>48 hypertensive women, 4 hypertensive men (middle and older age)</td>
<td>Perceived social support scale: perceived social support from family and friends Health social support: social support specific to health practices Preference for seeking social support under health care situations</td>
<td>SBP, DBP</td>
<td>Participants in health education—follow-up counseling and health education—follow-up counseling—organized support sites had increased voluntary participation in treatment programs for high blood pressure, weight loss, and smoking cessation compared with control and health education group</td>
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<td></td>
<td>Participants in health education—follow-up counseling and health education—follow-up counseling—organized support sites showed greater reductions in weight, smoking, SBP, and DBP than health education and control group</td>
</tr>
<tr>
<td>Erfurt et al. (1991)</td>
<td>Prospective Assessment period: (preintervention and 3-year postintervention) BS factor: (control site, health education site, health education—follow-up counseling site, and health education—follow-up counseling—organized plant support site)</td>
<td>1,883 out of 2,300 predominantly male (87% to 95%) employees rescreened 3 years later (M across sites = 43.7 to 46.3) Analyses examined only individuals identified as at risk during baseline: high blood pressure, more than 20% overweight, or smoker</td>
<td>Organized plant support: creation of informal health networks, peer support groups, and social activities</td>
<td>SBP, DBP</td>
<td>Results similar when only examining individuals who actively participated in intervention programs at the sites</td>
</tr>
</tbody>
</table>

Note. None of the studies included an endocrine or immune assessment. ANS = autonomic nervous system; BS = between subjects; DBP = diastolic blood pressure; SBP = systolic blood pressure.
assessed social support related to family members revealed a reliable combined test of significance ($z = 4.17$, $p = .00001$, fail-safe $n = 64.97$). The associated effect size for this analysis was $r = .12$, and no test of variability was significant ($p > .09$). In 1 study whose researchers directly examined blood pressure in the presence of different social relationships, Spitzer, Llabre, Ironson, Gellman, and Schneiderman (1992) found that being around a family member was associated with lower ambulatory SBP and DBP compared with being around a friend or a stranger. The prospective interventions with hypertensive patients that directly used family members as sources of support provide convergent evidence on the importance of familial sources of support on blood pressure regulation.

Researchers of 8 of the correlational studies have directly tested the potential stress-buffering effects of social support on cardiovascular function (Dressler, 1980, 1991; Dressler, Matar, et al., 1986; Janes, 1990; Kasi & Cobb, 1980; Kaufmann & Beehr, 1986; Strogatz & James, 1986; Winnubst et al., 1982). As argued by S. Cohen and Wills (1985), one methodological requirement for a test of the buffering model consists of demonstrating a significant main effect for the stress assessment to ensure that the measure was characterized by an adequate range of scores and measurement reliability. However, only researchers of 4 of these studies reported data indicating that their measure of stress was associated with blood pressure. These 4 studies were associated with a significant combined test ($z = 3.39$, $p = .0003$, fail-safe $n = 12.99$) and an effect size of $r = .18$. No test of variability was significant ($p > .34$). In 1 illustrative study, Dressler (1980) reported an interaction between structural measures of support (i.e., no. of siblings) and levels of life stress for SBP and DBP: Individuals high in number of siblings and low in life stress were characterized by the lowest blood pressure. Although Cohen and Wills suggest that buffering effects are more likely to be found when there is a reasonable match between the stressor type and support function, they also reported that buffering effects were sometimes found when researchers assessed close interpersonal relationships. Consistent with Cohen and Wills, all 5 studies whose researchers examined familial relationships (e.g., spouse and siblings) reported a significant buffering effect on cardiovascular regulation ($z = 3.43$, $p = .0003$, fail-safe $n = 16.74$), with an effect size of $r = .14$. No test of variability was significant ($p > .55$). These studies further underscore the potential importance of examining familial sources of social support in studies of cardiovascular regulation.

The studies summarized in Table 2 suggest that structured interactions with others may also produce beneficial effects on cardiovascular function. However, these results may not simply be a function of the intervention discussion because such structured interactions appear to generalize to others in one’s network (e.g., Andersson, 1985). Therefore, the studies in Table 2 may produce part of their effects by increasing social competence or the perceived importance of social interactions in one’s social network (Sallis et al., 1987).

At a more behavioral level of analysis, part of the association between social support and cardiovascular function may be a result of health-related lifestyle factors (Umberston, 1987). For example, social support may be associated with better cardiovascular regulation because individuals high in social support engage in better health practices (e.g., better diet and more physical activity). Contrary to this position, the associations between aspects of social support and cardiovascular function remained significant even after statistically controlling for a number of health-related variables, including weight or body mass (e.g., Bland et al., 1991; Janes & Pawson, 1986; Stavig, Igra, & Leonard, 1984). However, it should be noted that many of these researchers have not assessed specific health-related behaviors (e.g., substance abuse). In addition, of those researchers that did assess specific health-related behaviors, data on the reliability or validity of their assessments were typically not reported (see Umberston, 1987).

At a psychological level of analysis, perceptions of stress, feelings of controllability, intrusive or ruminative thinking, feelings of loneliness, depression, and other emotional processes (e.g., anxiety) are potential psychological mechanisms for the associations between social support and cardiovascular function (Collins, Dunkel-Schetter, Lobel, & Serinshaw, 1993; Pierce, Sarason, & Sarason, 1991; Quittner, Glueckauf, & Jackson, 1990; Russell & Cutrona, 1991; Stokes, 1985; Solomon, Mikulincer, & Hobfoll, 1986). Unfortunately, empirical data are unavailable concerning the psychological mechanisms responsible for the associations between social support and cardiovascular function reported in Tables 1–3. Future research is clearly needed in this area of inquiry. We return to this important point later in the review.

**Laboratory Studies Examining the Effects of Social Support on Cardiovascular Function**

Whereas the prior studies have focused primarily on tonic measures of cardiac function, many of the recent studies have been experimental, laboratory studies conducted under the rubric of the reactivity hypothesis. Briefly, the reactivity hypothesis suggests that exaggerated cardiovascular reactivity to stressors may be a pathogenic mechanism influencing the development of cardiovascular disorders (see Krantz & Manuck, 1984; Manuck, 1994; and Matthews et al., 1986). These 15 studies are summarized in Table 4. Thirteen of these studies tested relatively young participants under the age of 30. One study used a middle-aged sample, and 1 study used an older adult sample. Researchers of 8 of these studies exclusively examined women, of 3 examined men, and of 4 examined both men and women. In 11 studies, researchers examined social support through experimental manipulation. Researchers of the remaining 4 studies assessed naturalistic levels of social support. Of these 4 studies, 3 studies’ researchers examined functional measures of support, and 1 examined a combined index of structural and functional support.

The laboratory studies in Table 4 collectively suggest that social support may reduce cardiovascular (or autonomic nervous system) reactivity to acute psychological stress. One salient fea

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4 We should note that 4 of the 5 studies’ researchers who assessed familial sources of support also reported significant effects of their stress measures. Therefore, the influence of close interpersonal relationships and the methodological requirement suggested by S. Cohen and Wills (1985) are potentially confounded in these meta-analyses of buffering effects.
Table 4

Social Support and Cardiovascular Function: Laboratory Reactivity Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support-assessment-condition</th>
<th>ANS assessment</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Kiecolt-Glaser &amp; Greenberg (1984)</td>
<td>Experimental BS factor: interviewer condition (supportive and neutral) WS factor: epoch period (baseline, interview, stressor, and Stroop task)</td>
<td>32 women ($M = 28$) psychiatric patients</td>
<td>Supportive interviewer: smiled during interview, shook hands, introduced self by first name, maintained good eye contact, and periodically shared information on self</td>
<td>HR, skin resistance</td>
<td>Liked the supportive interviewer more and rated the supportive interview condition as warmer compared with the neutral interview condition. Interaction between interview condition and task load during the Stroop task for HR; During high task load participant had greater increases in HR during the strop task to the control compared with the supportive interview condition, whereas there was no difference as a function of interview condition under low task load.</td>
</tr>
<tr>
<td>Tardy et al. (1989)</td>
<td>Correlational BS factor: social support (low and high) WS factor: epoch period (baselines and talking about intimate topics)</td>
<td>18 men, 20 women ($M = 24$)</td>
<td>Social Support Questionnaire: support network and satisfaction with support Social Provisions Scale: six functional components of social support (guidance, reliable alliances, reassurance of worth, social integration, attachment, and opportunity for nurturance)</td>
<td>HR, SBP, DBP, MAP</td>
<td>Satisfaction with support (SSQ) negatively related to SBP during rest and talking period. Satisfaction with support (SSQ) negatively related to DBP and MAP during talking period and positively associated with HR during rest and talking period. Availability of support (SSQ) positively related to resting HR. Reliable alliances (SPS) negatively related to SBP during rest. No association between any social support measure and change from baseline to talking period. Availability of social support unrelated to HR and MAP reactivity to mental arithmetic, video game, or cold pressor task (i.e., mean max HR and MAP during mental arithmetic, video game, cold pressor tasks; minus mean min HR and MAP during the rest period).</td>
</tr>
<tr>
<td>Boyce &amp; Chesterman (1990)</td>
<td>Correlational BS factor: epoch period (baseline, video game, mental arithmetic, and cold pressor)</td>
<td>25 adolescent boys ($M = 15$)</td>
<td>Availability of social support: number of best friends, activities after school, club or team membership, good family friends, proximity of relatives, cohesiveness of extended family, and ability to talk to parents about problems</td>
<td>HR, MAP</td>
<td>Support conditions did not differ in terms of task performance or effort and emotional responses to tasks (i.e., anger, anxiety, and curiosity). Friend support associated with smaller increases in HR and SBP reactivity to mental arithmetic task compared with alone condition. Friend support associated with smaller increases in HR reactivity to concept formation tasks compared with alone condition. Friend support associated with smaller increases in DBP reactivity to structured interview compared with alone condition. Type A X Support Condition interaction for SBP reactivity to concept formation and structured interview task: Type As, but not Type Bs, showed increased SBP reactivity to tasks while alone but not with a friend.</td>
</tr>
<tr>
<td>Kamarck et al. (1990)</td>
<td>Experimental BS factor: support condition (friend and alone) WS factor: epoch period (baselines, mental arithmetic task, concept formation task, and Rosenman structured interview)</td>
<td>39 women ($M = 19$)</td>
<td>Friend condition: performed tasks in the presence of a close friend who was instructed to be silently supportive and touch person on wrist during tasks</td>
<td>HR, SBP, DBP</td>
<td>Support conditions did not differ in terms of task performance or effort and emotional responses to tasks (i.e., anger, anxiety, and curiosity). Friend support associated with smaller increases in HR and SBP reactivity to mental arithmetic task compared with alone condition. Friend support associated with smaller increases in HR reactivity to concept formation tasks compared with alone condition. Friend support associated with smaller increases in DBP reactivity to structured interview compared with alone condition. Type A X Support Condition interaction for SBP reactivity to concept formation and structured interview task: Type As, but not Type Bs, showed increased SBP reactivity to tasks while alone but not with a friend.</td>
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</table>
### Table 4 (continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment-condition</th>
<th>ANS assessment</th>
<th>Results</th>
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<tbody>
<tr>
<td>K.M. Allen et al. (1991)</td>
<td>Experimental BS factor: support condition at home only (friend, pet, and control) WS factors: epoch period (baselines and mental arithmetic task), test location (lab and home)</td>
<td>45 women dog owners ($M = 39$)</td>
<td>Friend condition: during home test, friend sat next to the person and was instructed to be supportive in any manner during tasks (no friend actually touched the person)</td>
<td>Pulse rate, SBP, DBP, SCR frequency</td>
<td>At home friend condition, performed less accurately and at a faster pace during mental arithmetic than control and pet conditions At home friend condition associated with increased SCR, SBP, and pulse rate reactivity to mental arithmetic task compared with control and pet condition, which was associated with the lowest reactivity</td>
</tr>
<tr>
<td>Edens et al. (1992)</td>
<td>Experimental BS factor: support condition (alone, stranger–no touch, stranger–touch, friend–no touch, and friend–touch) WS factor: epoch period (baselines, mental arithmetic, and mirror tracing)</td>
<td>60 undergraduate women</td>
<td>Friend–no touch: performed tasks in presence of close friend</td>
<td>HR, SBP, DBP</td>
<td>Support conditions did not differ in terms of performance on mental arithmetic task or mirror tracing task Touch conditions were associated with higher HR, SBP, and DBP reactivity to mental arithmetic than no-touch conditions Friend conditions were characterized by lower HR and DBP reactivity to mental arithmetic compared with stranger conditions Friend–no touch condition associated with lower SBP reactivity to mental arithmetic than alone condition No difference between friend–touch and alone condition on HR, SBP, or DBP</td>
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<tr>
<td>Gerin et al. (1992)</td>
<td>Experimental BS factor: support condition (support and no support) WS factor: epoch period (baseline and discussion task)</td>
<td>40 undergraduate women</td>
<td>Support condition: involved in topic discussion while two confederates attacked her position and one confederate defended her position No support condition: involved in topic discussion while two confederates attacked her position and one confederate is silent</td>
<td>HR, SBP, DBP</td>
<td>Proportion of time talking during discussion did not differ between support conditions Emotional responses to discussion (i.e., stress, enjoyment, want to leave, anxiety, anger, and want to return) did not differ between support conditions Support condition associated with lower increases in HR, SBP, and DBP reactivity to discussion task compared with no support condition (results similar for both quiet and talking discussion periods) Those who performed stressful tasks with friend present rated the observer as more friendly than with stranger present Friends and strangers were rated as equally nonevaluative and did not differ in task ratings of difficulty and effort Stranger condition associated with greater peak skin conductance and HR than alone condition Stranger condition associated with greater increases in peak skin conductance from anticipatory to task periods than the friend or alone condition (friend and alone conditions did not differ)</td>
</tr>
<tr>
<td>Synderstone &amp; Cacioppo (1992)</td>
<td>Experimental BS factor: support condition (friend, stranger, and alone) WS factor: epoch period (anticipatory and task)</td>
<td>34 women (17–25)</td>
<td>Friend support condition: friend present while performed stressful tasks Stranger condition: stranger present while performed stressful tasks</td>
<td>HR, SCL, peak SCR, number of nonspecific SCRs</td>
<td>(table continues)</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>Participants (age, in years)</td>
<td>Social support assessment-condition</td>
<td>ANS assessment</td>
<td>Results</td>
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<tr>
<td>Uchino, Knox, Kiecolt-</td>
<td>Correlational BS factors: helpful social support (low and high), chronic</td>
<td>13 caregiver men, 23 caregiver women, 6 control men, 28 control women (M = 63)</td>
<td>Social support interview: combined index of perceived emotional and tangible support from up to 10</td>
<td>HR, SBP, DBP</td>
<td>Age × Social Support × Chronic Stress × Period interaction for HR: Caregivers low on social support showed atypical age-related increases in HR reactivity to stressors, whereas caregivers high on social support showed typical age-related decreases in HR reactivity to stressors. Age × Social Support interaction for SBP: Individuals low on social support evidenced age-related increases in SBP, whereas no age-related changes were apparent in individuals high in social support. Similar effects when using the number of people listed in the social support interview as the measure of social support. Statistical controls for task performance, effort, affect, potential health-related variables (i.e., exercise, weight, caffeine consumption, alcohol consumption, and smoking habits), and depression revealed same pattern of results.</td>
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<tr>
<td>Glaser, Cacioppo (1992)</td>
<td>stress (caregivers and controls), and age (young and older)</td>
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<td>important people in one's life with whom one has contact</td>
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<tr>
<td>Lepore et al. (1993)</td>
<td>Experimental BS factor: support condition (speech-support, speech-no</td>
<td>43 men, 47 women (M = 21)</td>
<td>Speech–support condition: confederate made comments during speech designed to reflect emotional and</td>
<td>SBP, DBP</td>
<td>Speech–support conditions did not differ in terms of speaking time and speech quality. Speech–support condition was rated as more supportive than speech–no support condition. No group differences in perceived stress during speech task. Speech–no support condition had higher SBP and DBP reactivity to speech task than speech–support and speech-alone conditions. Speech-alone condition showed higher SBP reactivity to speech task than speech–support condition.</td>
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<td>support, and speech alone)</td>
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<td>self-esteem support</td>
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<td>WS factor: epoch period (baseline, anticipatory speech, and speech)</td>
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<td>Speech–no support condition: confederate was reserved and unattentive during speech</td>
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<tr>
<td>Knox (1993)</td>
<td>Correlational BS factor: social support (low and high)</td>
<td>29 men (M: low support = 25, high support = 23)</td>
<td>Support scale: prescreened to be relatively low or high in a combined index of instrumental and</td>
<td>HR, SBP, DBP</td>
<td>Social support group not significantly associated with state anxiety, anger inhibition, environmental stress, body mass index, or parental history of hypertension. Main effect for social support group on DBP: Low social support group was characterized by higher DBP than high social support group. Controlling for age rendered the main effect for social support on DBP nonsignificant.</td>
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<td>WS factor: epoch period (baseline, math, stroop, and cold pressor)</td>
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<td>emotional support</td>
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<tr>
<td>Sheffield &amp; Carroll</td>
<td>Experimental WS factors: social support (alone, friend, and stranger),</td>
<td>60 men, 60 women (M = 21)</td>
<td>Social support manipulation: performed the task with a close friend present</td>
<td>HR, SBP, DBP</td>
<td>No social support group difference on measures of perceived support, but friends seen as more evaluative than strangers. Alone condition performed worse on mental arithmetic task than friend and stranger conditions. Social support was not associated with any differences in cardiovascular reactivity to the task. Internal analyses grouping participants as low or high in perceived support and perceived evaluation revealed several post hoc interactions.</td>
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<td>(1994)</td>
<td>session (alone and social support), and epoch period (baselines, mental</td>
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<td>arithmetic, and vocabulary task)</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>Participants (age, in years)</td>
<td>Social support assessment-condition</td>
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<tr>
<td>Gerin et al. (1995)</td>
<td>Experimental</td>
<td>26 women (17–21)</td>
<td>Social support manipulation: performed the tasks with a roommate present</td>
<td>HR, SBP, DBP</td>
<td>Conditions did not differ in task performance</td>
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<td>WS factors: social support (alone and roommate), task stress (low and high), and epoch period (baseline and task)</td>
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<td>Main effect of social support on DBP: Roommate associated with lower overall DBP than the alone condition</td>
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<td>Interaction between social support and task stress for SBP and DBP reactivity: Alone condition associated with greater SBP and DBP reactivity as a function of stress than together condition</td>
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<td>Social support condition associated with lower perceived stress but no social support and task stress interaction for perceived stress</td>
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<td>Postsession questionnaire revealed that participants viewed roommate as helpful and nonevaluative</td>
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<tr>
<td>Kamarck et al. (1995)</td>
<td>Experimental</td>
<td>96 women (18–30)</td>
<td>Social support manipulation: performed first task (i.e., Stroop) with a close friend present</td>
<td>HR, SBP, DBP</td>
<td>Conditions did not differ in task performance</td>
</tr>
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<td>BS factors: social threat (low and high), social support (alone and with affiliative partner), WS factor: epoch period (baseline, Stroop, and mental arithmetic)</td>
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<td></td>
<td>Social Support × Social Threat interaction for SBP and DBP: Alone condition associated with greater SBP and DBP reactivity as a function of social threat than close friend condition</td>
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<td>Self-reported anger, anxiety, and task appraisal did not differ by condition</td>
</tr>
<tr>
<td>Lepore (1995)</td>
<td>Experimental</td>
<td>52 men, 52 women college students</td>
<td>Social support manipulation: confederate provided emotional support during speech task</td>
<td>HR, SBP, DBP</td>
<td>Conditions did not differ in speech duration or quality</td>
</tr>
<tr>
<td></td>
<td>BS factors: social support (support and no support), cynicism (low and high), WS factor: epoch period (baseline and speech task)</td>
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<td>Social support condition associated with lower SBP, DBP, and HR reactivity to the speech</td>
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<td>Social Support × Cynicism interaction for SBP and DBP reactivity: Individuals low in cynicism showed a decrease in SBP and DBP reactivity as a function of social support, whereas individuals high in cynicism showed no such difference</td>
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<td>Statistically controlling for perceived stress did not affect the Social Support × Cynicism interaction for SBP and DBP reactivity</td>
</tr>
</tbody>
</table>

Note. None of the studies included an endocrine or immune assessment. ANS = autonomic nervous system; BS = between subjects; DBP = diastolic blood pressure; HR = heart rate; MAP = mean arterial pressure; max = maximum; min = minimum; SBP = systolic blood pressure; SCL = skin conductance level; SCR = skin conductance response; SPS = Social Provisions Scale; SSQ = Social Support Questionnaire; WS = within subjects.
tured of the studies summarized in Table 4 is that strong results emerge with laboratory paradigms that manipulate the supportive functions of social relationships (Gerin, Pieper, Levy, & Pickering, 1992; Kiecolt-Glaser & Greenberg, 1984; Lepore, 1995; Lepore, Allen, & Evans, 1993), rather than simply relating naturalistic social support measures to laboratory stressors (e.g., Boyce & Chesterman, 1990; Tardy, Thompson, & Allen, 1989). The 4 studies whose researchers manipulated the supportive function of social relationships and examined its effects on cardiovascular reactivity were characterized by a significant combined test of significance ($z = 4.00$, $p = .00003$, fail-safe $n = 19.62$) and an effect size of $r = .28$. No test of variability was significant ($p > .32$). Such experimental studies provide strong evidence linking functional aspects of social support to changes in cardiovascular parameters. For example, Gerin et al. had participants engage in a discussion task in the presence or absence of social support. In the no social support condition, two confederates attacked the participant's views, while a third confederate sat silently. The discussion task was identical for the social support condition, however, the third confederate now defended the participant's views. Results of the study revealed that social support during the conflict discussion was uniformly associated with lower increases in heart rate, SBP, and DBP.

Although the laboratory studies are generally consistent with the notion that social support may reduce ANS reactivity to acute psychological stress, studies that have operationalized social support by having participants perform a stressful task in the presence of a relationship assumed to be supportive (e.g., friend) differ in the pattern of results obtained. In such studies, although the presence of a friend is associated with reduced ANS reactivity compared with the presence of a stranger (Edens, Larkin, & Abel, 1992; Snydersmith & Cacioppo, 1992), results regarding the presence of a friend compared with an alone condition are inconsistent. Researchers of 7 studies examined participants' ANS reactivity to acute psychological stress in such studies. Researchers of 3 studies have reported that ANS reactivity to brief psychological stress was lower when a friend was present than in the alone condition (Gerin, Milner, Chawa, & Pickering, 1995; Kamarck, Annunziato, & Amateau, 1995; Kamarck, Manuck, & Jennings, 1990). In contrast, researchers of 3 studies found no differences between these conditions (Edens et al., 1992; Sheffield & Carroll, 1994; Snydersmith & Cacioppo, 1992), and K. M. Allen, Blascovich, Tomaka, and Kelsey (1991) reported greater ANS reactivity in the friend condition compared with the alone condition. However, as suggested by Allen et al. (1991), the presence of a friend may have been associated with increased reactivity due to the evaluative nature of the situation, compared with Kamarck et al. (1990). Consistent with this notion, Allen et al. (1991) found that the friend condition was associated with a faster task rate and more task errors compared with the alone condition, whereas Kamarck et al. (1990) found no such performance differences.

The differences between Kamarck et al. (1990) and Edens et al. (1992) are more difficult to resolve. However, one explanation may lie in the interactions operating in the alone conditions. Although physically alone, participants in these conditions realized that their performance was being visually and physiologically monitored by the experimenter. All participants in both studies were women, however, the experimenter in Kamarck et al. was a man, whereas the experimenter in Edens et al. was a woman. The gender incongruence in the Kamarck et al. study may have contributed to increased evaluation apprehension and threat in the alone condition. Consistent with this reasoning, cardiovascular reactivity levels in the alone condition for Edens et al. were lower than those reported in the Kamarck et al. study. In fact, as suggested by Edens et al., had reactivity levels in the alone condition been comparable with Kamarck et al., these results may have replicated Kamarck et al.'s. This interpretation is also consistent with the results of Snydersmith and Cacioppo (1992) who found results similar to Edens et al. using a female experimenter interacting with female participants.

Finally, 2 studies (Gerin et al., 1995; Kamarck et al., 1995) suggest more specific conditions under which a friend is likely to be associated with lower cardiovascular reactivity compared with the alone condition during acute psychological stress. In particular, in both of these studies, researchers manipulated the degree of threat or stress present while the participants performed the psychological tasks. Results of these studies revealed that buffering effects of the friend condition relative to the alone condition are likely to be found when the situation is especially threatening or stressful. In general, the studies summarized in Table 4 provide evidence on the boundary conditions (i.e., degree of evaluation and threat) under which a friend may reduce cardiovascular reactivity to stress.

The laboratory studies linking social support to phasic changes in cardiovascular function provide evidence that social support may be important in reducing cardiovascular reactivity to psychosocial stressors. The laboratory studies provide a potentially important conceptual link to the studies summarized in Tables 1–3 that focused on tonic blood pressure in middle-aged to older adult community samples. More specific, social support may be conceptualized as a stable individual difference variable (I. G. Sarason, Sarason, & Shearin, 1986), therefore, laboratory paradigms may provide a model of how social support operates in everyday life. The laboratory studies suggest that the higher cardiovascular reactivity seen in situations involving low social support may translate to gradual elevations in tonic blood pressure across the lifespan. In a relevant study, Light, Dolan, Davis, and Sherwood (1992) examined the use of cardiovascular reactivity to acute stressors in predicting subsequent tonic blood pressure levels. Results revealed that individuals high in heart rate reactivity evidenced elevated tonic blood pressure 10 to 15 years later compared with individuals low in heart rate reactivity. Significantly, these groups were initially characterized by comparable tonic blood pressure levels. These data are consistent with animal models of hypertension, suggesting that exaggerated cardiovascular reactivity influences the development of cardiovascular disorders (Folkow, Hallback, Lundgren, Sivertsson, & Weiss, 1973; Hallback & Folkow, 1974; Manuck, Kaplan, & Clarkson, 1983).

### Potential Mechanisms Linking Social Support to Reduced Cardiovascular Reactivity

The laboratory studies are suggestive of several different mechanisms linking social support to reduced cardiovascular reactivity. At a social psychological level, nonevaluative friends...
appear to buffer cardiovascular reactivity to highly threatening psychosocial stressors compared with the stranger or alone condition. One should note, however, that most of these studies used undergraduate samples, and friends may be a particularly important source of support in such younger populations.

These studies are also suggestive of the particular dimensions or functions of social support that may reduce cardiovascular reactivity in response to certain stressors or situations. In particular, the dimension of emotional support appears to be a salient feature operating in these experiments to reduce cardiovascular reactivity (Edens et al., 1992; Gerin et al., 1992, 1995; Kamarck et al., 1990, 1995; Kiecolt-Glaser et al., 1985; Lepore, 1995; Lepore et al., 1993; Snydersmith & Cacioppo, 1992). These findings do not suggest that other aspects of social support (e.g., appraisal support) are unimportant because most of the studies in Table 4 have used stressors in which emotional support may be especially important. Appraisal support, for instance, cannot be effective if there is no opportunity for discussion in these studies. Therefore, consistent with past research (S. Cohen & Wils, 1985; Cutrona & Russell, 1990) and the studies summarized thus far, the laboratory paradigms suggest that particular functions of social support are more effective when there is a reasonable match with the demands of particular situations. On the basis of the studies presented in Tables 1–3, the match between the support dimension and stressor may also need to be considered in the context of cultural and gender-related processes.

In many of these studies, data were provided regarding potential behavioral mechanisms linking manipulated or naturalistic social support with lowered cardiovascular reactivity. The studies in Table 4 suggest that behavioral factors, such as potential health-related variables (e.g., Uchino, Kiecolt-Glaser, & Cacioppo, 1992) and performance indices during the tasks (Edens et al., 1992; Gerin et al., 1992, 1995; Kamarck et al., 1990, 1995; Lepore, 1995; Lepore et al., 1993; Snydersmith & Cacioppo, 1992; Uchino et al., 1992) were not responsible for the results obtained in these studies. Therefore, consistent with the correlational studies reviewed earlier, the laboratory studies suggest that behavioral factors are not necessary for associations between social support and cardiovascular reactivity.

Several studies in Table 4 examined the possibility that specific psychological and emotional reactions during the laboratory tasks mediated the effects of social support on cardiovascular reactivity. These studies’ researchers generally reported that participants’ emotional reactions during the experiment did not differ as a function of the social support conditions (Edens et al., 1992; Gerin et al., 1992, 1995; Kamarck et al., 1990, 1995; Lepore, 1995; Lepore et al., 1993; Snydersmith & Cacioppo, 1992; Uchino et al., 1992) and therefore do not appear to be responsible for the pattern of results in these studies. In an illustrative study, Lepore et al. (1993) had participants perform a speech, while in one condition a confederate made comments designed to reflect emotional support. In contrast, the confederate in the low emotional support condition was reserved and inattentive. Results indicated that the social support speech condition was associated with lower SBP and DBP reactivity than the no support speech condition. In addition, results revealed that these conditions did not differ in terms of perceived stress during the speech. Data from 2 additional studies relating naturalistic social support to cardiovascular indices during acute psychological stress reveal that results were not a function of depression (Uchino et al., 1992) or environmental stress (Knox, 1993). Whether this lack of mediation by psychological reactions reflects methodological issues related to the retrospective nature of these assessments or the possibility that other unmeasured psychological processes may be important (e.g., feelings of controllability and intrusive thoughts) is beyond the scope of the existing literature. Future research is necessary to elucidate the potential psychological mechanisms operating in laboratory reactivity paradigms.

Social Support and Endocrine Function

Endocrine literally refers to the internal secretion of biologically active substances. These biologically active substances, or hormones, are usually defined as substances that are released from an endocrine gland (e.g., pituitary) into the blood stream to act on a distant target tissue site (see Greenspan & Baxter, 1994). Hormones can act in either an autocrine (i.e., act on the same cells that produced them) or paracrine (i.e., act on cells other than those that produced them) fashion. The major endocrine glands include the thyroid, pituitary, pancreas, adrenal medulla, adrenal cortex, testes, and ovaries.

The most commonly examined endocrine measures in stress research include the catecholamines (e.g., norepinephrine and epinephrine) and cortisol. Epinephrine (EPI) is produced and released into the blood stream from the adrenal medulla. Norepinephrine (NE) is also synthesized in the adrenal medulla but is largely produced in the central nervous system and peripheral sympathetic nerves. Catecholamines bind to adrenergic receptors where their effects are to increase oxygen and heat consumption and activate glucose and fat from storage areas in the body. Some important physiologic changes in response to catecholamines include increased heart rate, increased myocardial contractility, changes in vascular resistance, and regulation of renin secretion from the kidneys.

Cortisol is a cholesterol-derived steroid, secreted from the adrenal cortex where it acts through the cytosolic glucocorticoid receptor protein. Cortisol secretion is a result of complex regulatory processes and involves corticotropin releasing hormone (CRH) and ACTH. The biologic process is initiated, in part, by the release of CRH from the hypothalamus that signals the pituitary gland to secrete ACTH. ACTH then signals the adrenal cortex to release cortisol and later serves to regulate the amount of cortisol secreted. Once released, cortisol has a variety of metabolic effects, including increased glucose metabolism and down regulation of immune function.

An examination of endocrine function is important because of its association with both the cardiovascular and immune systems. As reviewed earlier, the catecholamines play an important role in cardiovascular regulation. For instance, catecholamines bind to alpha-adrenergic receptors and lead to constriction of arterial smooth muscles. Furthermore, catecholamines appear to be toxic to endothelial cells of the arteries (Krantz & Mauk, 1984). Damage to the endothelial cells of the arteries is thought to be an important initiating factor in the development of coronary atherosclerosis (Gorlin, 1976).

Clearly, important interactions exist between the endocrine and
immune systems (Ader, Felton, & Cohen, 1991). Lymphocytes appear to have beta-adrenergic, gluco corticoid, and opioid recep tors (Plaut, 1987; Sibinga & Goldstein, 1988). More significantly, hormones influence numerous aspects of immune function. For instance, the acute release of catecholamines produce transient increases in natural killer (NK) cell lysis (i.e., an in vitro model of the functional ability of NK cells to lyse or destroy tumor or virus-infected cells; Tonnese, Christensen, & Brinklev, 1987) and decreases in the proliferative response to mitogens (i.e., an in vitro model of the functional ability of lymphocytes to proliferate when faced with a challenge; Crary et al., 1983). In addition, glucocorticoids have regulatory effects on immune responses, including decreased NK cell lysis (Gatti et al., 1987) and mitogen proliferation (Rupprecht et al., 1990). Prolactin, growth hormone, estradiol, testosterone, opioids, CRH, and ACTH also have immunomodulatory effects (see reviews by Blalock, 1989; Carr, 1991; and Cupps & Fauci, 1982).

The measurement reliability of commonly examined endocrine measures (e.g., catecholamines and cortisol) is well documented. For instance, one of the most accurate and cost-effective techniques, radioimmunoassay (RIA), uses specific binding substances (e.g., antibody) with radioactive tracers to quantify endogenous hormones in bodily fluids (see Bissette & Ritchie, 1992; Chard, 1982 and Jaffe & Behrman, 1979). RIA has very good specificity and sensitivity and is characterized by low intra-assay variability (i.e., typically less than 1% to 5%). However, the interassay variability may vary depending on factors such as the stability of solutions and radioactive tracers, incubation temperature and duration, and changes in the sample matrix and technicians (Bissette & Ritchie, 1992). Nevertheless, quality control procedures (e.g., monitoring standard curve parameters) are typically implemented such that interassay variability below 10% may be achieved (Bissette & Ritchie, 1992).

Little data exist on the temporal stability of interindividual variations in endocrine function. There are a variety of methodological issues worth considering in examining the temporal stability of endocrine measures (see reviews by Baum & Grunberg, 1995; and McKinnon, Baum, & Morokoff, 1988). First, there are diurnal variations associated with both catecholamines and cortisol (Akerstedt & Levi, 1978; Greenspan & Baxter, 1994). Therefore, if only a limited number of samples are drawn, it is important to collect such samples at approximately the same time to reduce this extraneous and potential confounding source of variance. In addition, even if samples are obtained at the same time, the point in the diurnal cycle that endocrine function is assessed may be important. For instance, cortisol has a diurnal cycle that peaks during the morning hours (Greenspan & Baxter, 1994) so that relationships with social support may be more difficult to detect at this time. Thus, one may need to examine the relationship between social support and cortisol across the full range of the diurnal cycle.

Second, it is important to distinguish whether endocrine measures are assessed in plasma or urine (Baum & Grunberg, 1995). This distinction is especially relevant for the assessment of plasma catecholamines that have a relatively short half-life of 1–3 min. As a result, plasma assessments of catecholamines provide data on transient changes in endocrine function. Urinary assessments, however, provide information on more chronic or long-term alterations in endocrine function but are relatively insensitive to short-term bursts of catecholamines.

Finally, the method of obtaining samples for endocrine assessments may contribute significant sources of variance. If plasma samples are assessed, blood draws that are obtained from a single needle stick can elevate catecholamines and make relationships with social support more difficult to detect. Therefore, the use of a catheter with a rest period that allows for changes due to venipuncture to subside is typically recommended (Baum & Grunberg, 1995). The use of urinary samples is associated with different methodological considerations. For instance, compliance with 24-hr urine samples may be problematic so that 15-hr overnight samples are useful (Baum & Grunberg, 1995).

As evidenced by inspection of Table 5, the association between social support and endocrine function has not been well studied. Only 10 studies included endocrine assessments: 4 examined catecholamines, 4 examined cortisol, and 2 examined both. In 4 studies, the investigators assessed hormones in urine, in 1 study hormones were assessed in saliva, and in 1 study hormones were assessed in breast milk. In addition, 4 studies assessed plasma endocrine measures, and only 1 study (Knox et al., 1985) mentioned that they had drawn blood from a catheter that was inserted before a rest period. As noted earlier, this may be important because the needle stick associated with a single blood draw can elevate catecholamines and make relationships more difficult to detect.

In regard to sample characteristics, 4 studies examined only men, 2 studies examined only women, and 4 studies used both men and women. Social support was also operationalized in several ways: 6 studies assessed naturalistic social support levels, and 4 studies manipulated social support (i.e., interventions and laboratory reactivity studies). Of the 6 studies that assessed naturalistic social support, 4 assessed functional aspects of support, 1 assessed both structural and functional aspects of support, and 1 assessed a combined index of both structural and functional aspects of support.

Because of the small number of studies and differences in the operationalization of social support (e.g., naturalistic social support and laboratory manipulations), we performed a qualitative analyses of the studies whose researchers examined social support and endocrine function. To this point, researchers of 5 of the 6 studies reported an association between social support and catecholamines levels (Arnetz, Edgren, Levi, & Otto, 1985; Ely & Mostardi, 1986; Fleming, Baum, Gisriel, & Gatchel, 1982; Knox et al., 1985; Seeman, Berkman, Blazer, & Rowe, 1994). In an early study, Fleming et al. examined the influence of perceptions of support in participants exposed to the chronic stress of Three-Mile Island and in control participants. Results revealed that individuals low on social support were uniformly characterized by higher urinary NE levels than individuals high on social support (a similar but nonsignificant trend was found for EP).

Of the 6 studies whose researchers have examined cortisol
levels, researchers of 4 have found no association with social support (Arnetz et al., 1983, 1985, 1987; Groer, Humenick, & Hill, 1994). Two of these studies are interventions (i.e., Arnetz et al., 1983, 1987), and 1 of these studies' data suggest the intervention successfully increased social contact (Arnetz et al., 1983). Although the number of studies is small, these data suggest that simply increasing social contact may be insufficient to affect cortisol levels, at least at nomothetic levels of analysis. However, there are important issues that may have prevented an adequate test of the relationship between social support and tonic cortisol levels. First, idiographic analyses of cortisol changes to brief psychological stressors suggest that such changes may be heightened in individuals characterized by high cardiac sympathetic reactivity (Cacioppo et al., 1995). An examination of individual differences, therefore, may provide additional information about the effects of social support on cortisol levels.

In this regard, laboratory paradigms of social support may be helpful to examine phasic cortisol response. In a recent study, Kirschbaum, Klauer, Filipp, and Hellhammer (1995) examined the influence of social support from a stranger or partner (i.e., boyfriend or girlfriend) on cortisol reactivity during acute psychological stress. Results revealed that partner-supported men showed significantly lower cortisol levels than the stranger-supported or no-support conditions. In contrast, women showed a trend toward greater cortisol response during the partner-supported compared with the other two conditions, even though women reported feeling supported by their partners. These results, however, should be considered preliminary and require replication.

There is another potential reason why the intervention studies summarized in Table 4 did not find a relationship between social support and cortisol levels. The studies summarized earlier in Tables 1–3 on social support and cardiovascular function suggest that familial sources of social support may be important. None of the intervention studies was designed to facilitate familial sources of support. In addition, none of these studies' researchers examined the potential generalization of their intervention program to such support sources.

Three of the 4 studies that did not find a relationship between social support and cortisol obtained specimens primarily during the morning hours. One potential problem with a morning assessment is that cortisol has a diurnal cycle that peaks during the morning hours (Greenspan & Baxter, 1994). Therefore, the higher cortisol levels seen during morning hours may make it more difficult to detect relationships between social support and tonic cortisol levels. It is therefore promising that Seeman et al. (1994) examined 12-hr urinary cortisol samples and reported relationships between social support and cortisol levels in men. The study by Seeman et al. is also one of the most methodologically rigorous because the researchers also statistically controlled for a variety of potential confounding variables (e.g., age, medication use, and body mass).

Potential Mechanisms Linking Social Support to Endocrine Function

On the basis of Table 5, there appears to be preliminary evidence for a relationship between social support and catecholamine levels. Researchers of 2 studies conducted under the stress-buffering model found no evidence for a buffering effect on catecholamine levels for participants faced with job termination (Cobb, 1974) or chronically stressed Three-Mile Island residents (Fleming et al., 1982). Moreover, both studies' researchers found that the stressor was associated with significant elevations in catecholamine levels. Because of the small number of studies, more data are needed to adequately test the stress-buffering model on catecholamine levels.

In a small number of studies summarized in Table 5, researchers have examined psychological processes and its relationships to social support (Arnetz et al., 1985; Fleming et al., 1982; Kirschbaum et al., 1995). Fleming et al. found that high social support was associated with lower depression and anxiety, along with lower feelings of alienation. However, analyses specifically examining mediating or moderating mechanisms were not conducted because they were not a primary aim of the study.

In the study by Arnetz et al. (1985), social support was conceptualized by examining neurotic boys' endocrine responses to an exciting and partly violent film in either a different school (i.e., low support) or same school (i.e., high support) setting. Arnetz et al. found that the low support condition was associated with greater catecholamine changes in response to the film than the high support group. In addition, the low support group later preferred to review film scenes representing feeling of security, whereas the high support group preferred to review film scenes representing danger, suggesting that increased feelings of anxiety may be one mechanism operating in this study.

The laboratory social support study by Kirschbaum et al. (1995) examined perceptions of support and stress and found that these psychological mechanisms could not explain the obtained pattern of results. These results are consistent with those summarized in Table 4. All in all, more research is needed on the relationship between social support and endocrine function, along with an examination of psychological and behavioral (e.g., health-related) mechanisms responsible for these associations. Greater attention to methodological issues in examining the relationship between social support and endocrine function (e.g., sufficient rest period after needle stick) may also prove useful.

Social Support and Immune Function

The immune system is the body's defense against infectious and malignant disease (see Borysenko, 1987; Calabrese, Klinger, & Gold, 1987; and Kiecolt-Glaser & Glaser, 1988b, 1995, for basic reviews). The major organs of the immune system are the thymus, bone marrow, lymph nodes, spleen, tonsils, appendix, and Peyter's patches.

There is no single measure of immune function, and researchers in the field of psychoneuroimmunology (PNI) have used various measures to index aspects of immune function. A distinction has typically been made between quantitative and functional measures of the immune system (Kiecolt-Glaser & Glaser, 1988a). Quantitative measures can include absolute counts or percentages of certain immune cells such as helper T cells, suppressor/cytotoxic T cells, and NK cells. Quantitative measures are typically examined because both the number and
Table 5  
Social Support and Endocrine and Immune Functions

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment-condition</th>
<th>ANS assessment</th>
<th>Endocrine assessment</th>
<th>Immune assessment</th>
<th>Results</th>
</tr>
</thead>
</table>
| Cobb (1974) | Correlational with multiple physiological assessments  
Assessment period (anticipation of job loss, termination, 6 months post, 12 months post, and 24 months post) | 174 men ($M = 49$) | Perceptions of social support primarily from wife but also friends and relatives | None | Urinary NE | None | Social support unrelated to NE levels |
| Fleming et al. (1982) | Correlational  
BS factor: chronic stress  
(Three-Mile Island residents and controls) | 35 randomly sampled Three-Mile Island residents, 74 randomly sampled controls from demographically similar areas | Social support: perceived access to emotional support systems | None | Urinary NE, EPI | None | Low social support associated with greater self-reported symptoms, depression, anxiety, and alienation  
Interaction between social support and chronic stress for symptoms and depression: Low social support for Three-Mile Island residents associated with increased symptoms and depression (marginally significant trend for anxiety and alienation)  
Low social support associated with increased urinary NE but not EPI  
No interaction between social support and chronic stress for NE and EPI  
Social interaction group reported engaging in more internal activities and increased attendance in outside organizational groups than the control group  
Social interaction group showed less of a decline in testosterone over 6-month period compared with controls  
Social interaction group had increased DHEA at 3-month assessment compared with controls  
Social interaction group evidenced greater increases in estradiol over 6-month period compared with controls  
Social interaction group showed stable levels of growth hormones, whereas controls showed an increase over the 6-month period  
Boys in the low support condition preferred to review film scenes representing feelings of security, whereas high support boys preferred to review film scenes representing danger  
Boys in the low support condition showed greater increases in EPI to film than boys in the high support condition  
Boys in the low support condition showed no change in NE to film, whereas boys in the high support condition showed decreases in NE to film |
Table 5 (continued)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment-condition</th>
<th>ANS assessment</th>
<th>Endocrine assessment</th>
<th>Immune assessment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knox et al. (1985; also in Table 1)</td>
<td>Correlational</td>
<td>56 hypertensive, 27 normotensive, 23 hypertensive men (M at initial testing = 28)</td>
<td>ISSI scale: number of contacts for different dimensions of social support (e.g., attachment and friendship)</td>
<td>HR, SBP, DBP</td>
<td>Serum EPI, NE, renin activity</td>
<td>None</td>
<td>Excluded participants on medication Number of contacts averaged across different dimensions of social support negatively related to DBP Attachment and number of acquaintances associated with lower EPI in path model predicting SBP Number of contacts with acquaintances associated with lower HR in path model predicting DBP High social support (LAI) associated with lower NE than low social support</td>
</tr>
<tr>
<td>Ely &amp; Mostardi (1986; also in Table 1)</td>
<td>Correlational</td>
<td>331 men (20–69)</td>
<td>LAI: combined index of self-perception, marital relationship, social support systems, and social resources from community and friends</td>
<td>HR, SBP, DBP</td>
<td>Serum EPI, NE</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Arnetz et al. (1987)</td>
<td>Prospective assessment period (baseline and variable months)</td>
<td>9 unemployed women (M = 38), 8 unemployed women with psychosocial intervention (M = 37), 8 employed women (M = 38)</td>
<td>Social support: unemployed women with psychosocial intervention (i.e., self-help group that discussed and exchanged information on employment issues and participated in alternative activities)</td>
<td>None</td>
<td>Serum cortisol, PHA, number of helper T cells, suppressor/ cytotoxic T cells, NK cells, B cells</td>
<td>None</td>
<td>No difference on physiological measures as a function of psychosocial intervention</td>
</tr>
<tr>
<td>Seeman et al. (1994)</td>
<td>Correlational</td>
<td>337 healthy men, 391 healthy women (70–79)</td>
<td>Social network ties: total number of children, close friends, and relatives perceived emotional and instrumental support from social network</td>
<td>None</td>
<td>12-hr overnight urine NE, EPI, cortisol</td>
<td>None</td>
<td>Statistical controls performed for age, chronic conditions, body mass index, pack-years of cigarette smoking, and medication use In general, lower emotional support and lower social network ties associated with higher urinary NE, EPI, and cortisol for men Social Support X Gender interaction for overall salivary cortisol levels: Men showed lower cortisol levels in partner support than stranger support and no support conditions, whereas women showed a tendency toward higher cortisol levels in partner support than stranger support and no support conditions Perceived stress and stress did not explain the results above Social contact not associated with changes in any immune measure</td>
</tr>
<tr>
<td>Kiecolt-Glaser et al. (1985)</td>
<td>Experimental</td>
<td>32 men, 34 women (19–29)</td>
<td>Social support manipulation: strangers or boy- or girlfriend provided emotional and instrumental support and were present only during speech preparation period</td>
<td>None</td>
<td>Salivary cortisol</td>
<td>None</td>
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<td></td>
<td>BS factor: social support (no support, support by stranger, and support by boy or girlfriend)</td>
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<td>WS factor: epoch period (baseline, speech preparation, speech task, and mental arithmetic)</td>
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<tr>
<td></td>
<td>Social contact (social contact, relaxation, and no contact)</td>
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<tr>
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<td>WS factor: assessment period (baseline, end of intervention, and 1-month follow-up)</td>
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<tr>
<td></td>
<td>9 men, 36 women (M = 74)</td>
<td></td>
<td></td>
<td>None</td>
<td>NKCA, HSV–1, PWM, PHA</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

(table continues)
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants (age, in years)</th>
<th>Social support assessment—condition</th>
<th>ANS assessment</th>
<th>Endocrine assessment</th>
<th>Immune assessment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas et al.</td>
<td>Correlational</td>
<td>256 healthy people, 54% women (61–89)</td>
<td>Interview schedule for Social Interaction Scale: number of frank and confiding relationships</td>
<td>None</td>
<td>None</td>
<td>PHA</td>
<td>Analyses performed statistically controlling for smoking, body mass, age, alcohol consumption, and perceived psychological distress. Women high in social support were characterized by a stronger proliferative response to PHA than women low in social support. Social support consistently related to stronger proliferative response to Con A, PHA, and PWM at pre- and postoperation assessments but significant only for postoperative PHA. Total social support and all components positively related to PHA and NKCA, even after controlling for life events and depression. Social support unrelated to Con A.</td>
</tr>
<tr>
<td>Linn et al.</td>
<td>Prospective Assessment period (preoperative, 3 days postsurgery, and 30 days postsurgery)</td>
<td>24 men experiencing first-time hernia repair surgery ($M = 59$)</td>
<td>MAPS: perceived social support to stressful events during the preceding 6 months</td>
<td>None</td>
<td>None</td>
<td>Con A, PHA, PWM, neutrophil chemotaxis</td>
<td></td>
</tr>
<tr>
<td>R. S. Baron et al.</td>
<td>Correlational</td>
<td>2 men, 21 women as spouses of cancer patients ($M = 48$)</td>
<td>SPS: six functional components of perceived social support (guidance, reliable alliances, reassurance of worth, social integration, attachment, and opportunity for nurturance)</td>
<td>None</td>
<td>None</td>
<td>PHA, Con A, NKCA</td>
<td></td>
</tr>
<tr>
<td>Levy et al.</td>
<td>Correlational</td>
<td>61 women cancer patients from larger sample of 120 women cancer patients (25–70)</td>
<td>Perceived emotional support (i.e., person listens to concerns) for spouse (or intimate other), family member, friend, nurse, and doctor</td>
<td>None</td>
<td>None</td>
<td>NKCA</td>
<td>Emotional support from spouse (or intimate other) and doctor associated with greater NKCA.</td>
</tr>
<tr>
<td>Theorell et al.</td>
<td>Correlational</td>
<td>39 men, 10 women ($M = 42$)</td>
<td>Availability and adequacy of social support from close family and friends, coworkers, neighbors, and others</td>
<td>None</td>
<td>None</td>
<td>Serum IgG</td>
<td>Adequacy of social support negatively related to serum IgG at high levels of job strain but not lower levels of job strain. Availability of social support unrelated to serum IgG.</td>
</tr>
<tr>
<td>McNaughton et al.</td>
<td>Correlational</td>
<td>33 women ($M = 74$)</td>
<td>SSQ: support network and satisfaction with support</td>
<td>None</td>
<td>None</td>
<td>Numbers of CD4+ and CD8+ cells, ratio of CD4+ to CD8+ IgG anti-KLH Ab levels</td>
<td>Perceived emotional support negatively related to CD8+ cells. Social support unrelated to CD4+ cells. Social support unrelated to IgG antibody levels at any assessment period.</td>
</tr>
<tr>
<td>Snyder et al.</td>
<td>Prospective Assessment period (preimmunization baseline, 3 weeks postimmunization, and 8 weeks postimmunization)</td>
<td>89 women (18–24)</td>
<td>SSQ: asked to list individuals in their social network and rate the perceived informational and emotional support each provided</td>
<td>None</td>
<td>None</td>
<td>Social support unrelated to IgG</td>
<td></td>
</tr>
<tr>
<td>Schlesinger &amp; Yodfat</td>
<td>Correlational</td>
<td>46 married couples (men $M = 46$, women $M = 44$)</td>
<td>Social Support System Questionnaire</td>
<td>None</td>
<td>None</td>
<td>NKCA, CD57+ and CD16+ cells</td>
<td>Social support unrelated to NKCA and CD57+ and CD16+ cells.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Participants (age, in years)</td>
<td>Social support assessment-condition</td>
<td>ANS assessment</td>
<td>Endocrine assessment</td>
<td>Immune assessment</td>
<td>Results</td>
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</tr>
<tr>
<td>Kiecolt-Glaser et al. (1991)</td>
<td>Prospective Assessment period (Year 1 and Year 2) BS factor: chronic stress (caregivers and control)</td>
<td>20 men, 49 women in each chronic stress condition (caregiver $M = 67$, control $M = 68$)</td>
<td>Social support interview: assessed perceived helpful and upsetting aspects of both emotional and tangible support from up to 10 important people with whom one has contact</td>
<td>None</td>
<td>None</td>
<td>Con A, PHA, EBV, percentage of helper T cells, percentage suppressor T cells, NK cells, and B cells</td>
<td>Caregivers reported less (a) number of important people in their lives with whom they have contact, (b) frequency of support, (c) closeness of relationships, (d) helpful emotional support, and (e) helpful tangible support than controls; no group differences on upsetting emotional or upsetting tangible support</td>
</tr>
<tr>
<td>Glaser et al. (1992)</td>
<td>Prospective Assessment period (first injection of Hepatitis B, second injection 1 month later, and booster injection at 6 months)</td>
<td>25 men, 23 women 2nd year medical students ($M = 23$)</td>
<td>ISEL: total perceived social support averaged across multiple functional dimensions</td>
<td>None</td>
<td>None</td>
<td>Ab titers to HBsAg, T-lymphocyte response to Hep B SAg</td>
<td>Statistical controls for Ab titers and T-lymphocyte response during second inoculation and anxiety during third inoculation revealed that overall social support positively related to a summary index of Ab titers and T-lymphocyte response to Hep B SAg during third inoculation</td>
</tr>
<tr>
<td>Goodkin et al. (1992)</td>
<td>Correlational</td>
<td>62 asymptomatic HIV+ gay men ($M = 34$)</td>
<td>SPS: total perceived social support averaged across multiple functional dimensions</td>
<td>None</td>
<td>None</td>
<td>NKCA</td>
<td>No main effect of social support on NKCA</td>
</tr>
<tr>
<td>Perry et al. (1992)</td>
<td>Prospective Assessment periods (baseline, 6 months, and 12 months)</td>
<td>221 HIV+ patients without AIDS, 93% men ($M = 35$)</td>
<td>ISEL: total perceived social support averaged across multiple functional dimensions</td>
<td>None</td>
<td>None</td>
<td>CD4+ cell counts, CD8+ cell counts, percentage of CD4+ cells, ratio of CD4+ to CD8+ at baseline</td>
<td>Total social support unrelated to CD4+, CD8+, percentage of CD4+, and the ratio of CD4+ to CD8+ at baseline</td>
</tr>
<tr>
<td>Snyder et al. (1993)</td>
<td>Prospective Assessment period (baseline, 3 weeks, and 8 weeks)</td>
<td>89 women (18–24)</td>
<td>SSQ: asked to list individuals in their social network and rate the perceived informational and emotional support each provided</td>
<td>None</td>
<td>None</td>
<td>KLH lymphocyte proliferation at optimal concentration of 50 µg/ml</td>
<td>Social support associated with a stronger proliferative response to KLH at baseline but not at 3-week or 8-week assessment</td>
</tr>
<tr>
<td>Esterling et al. (1994)</td>
<td>Correlational BS factor: group (continuing caregivers, bereaved caregivers, and controls)</td>
<td>Continuing caregivers: 5 men, 9 women ($M = 68$); Bereaved caregivers: 5 men, 12 women ($M = 72$); Controls: 9 men, 22 women ($M = 71$)</td>
<td>Social support interview: assessed perceived helpful and upsetting aspects of both emotional and tangible support, as well as perceived closeness for up to 10 important people with whom one has contact</td>
<td>None</td>
<td>None</td>
<td>rIL-2 and rFN-γ stimulated NKCA</td>
<td>Caregivers (i.e., continuing and bereaved) low in NKCA to both rIL-2 and rFN-γ were characterized by lower helpful emotional and tangible support and less closeness in their relationships compared with caregivers high in NKCA to both rIL-2 and rFN-γ</td>
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</table>

(table continues)
<table>
<thead>
<tr>
<th>Study</th>
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<th>Endocrine assessment</th>
<th>Immune assessment</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esterling et al. (1994), continued</td>
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</tr>
<tr>
<td>Groer et al. (1994)</td>
<td>Correlational</td>
<td>34 preterm mothers ($M = 29$)</td>
<td>Personal Resource Questionnaire: overall perceived and situational social support</td>
<td>None</td>
<td>Preterm milk cortisol</td>
<td>Preterm milk sIgA</td>
<td>NKCA to both rIL-2 and rIFN-y but did not differ in the total number of illnesses, length of illness episode, or health-related behaviors</td>
</tr>
<tr>
<td>Persson et al. (1994)</td>
<td>Correlational</td>
<td>47 HIV+ men with AIDs ($M = 37$) recruited from all known HIV+ gay men in Malmo; No differences in background variables between participants and nonparticipants</td>
<td>Social network: general index consisting of close friends, family, etc.; family contact; social anchorage; social participation; and satisfaction with social participation</td>
<td>None</td>
<td>None</td>
<td>CD4+ counts</td>
<td>Low social participation, low satisfaction with social participation, low material support, and low emotional support (marginal effect) associated with lower CD4+ counts compared with individuals scoring high on these social support measures (odds ratios: 2.8 to 3.9)</td>
</tr>
<tr>
<td>Theorell et al. (1995)</td>
<td>Prospective</td>
<td>48 HIV+ men ($M = 32$) recruited from personal contacts with all known HIV+ hemophiliacs in Sweden; Most participants had known of HIV+ status for approximately 1 year before the study</td>
<td>Availability of Attachment Scale of the Social Network Support Questionnaire: availability of social and emotional support during difficult situations</td>
<td>None</td>
<td>None</td>
<td>CD4+ counts</td>
<td>Statistically controlling for HIV symptom severity did not alter results reported above</td>
</tr>
</tbody>
</table>

**Note:** Ab = antibody; ANS = autonomic nervous system; BS = between subjects; CD4+ and CD8+ = baseline quantitative measures of immunity; Con A = concanavalin A; DBP = diastolic blood pressure; DHEA = dehydroepiandrosterone; EBV = Epstein–Barr Virus; EP1 = epinephrine; HbAg = hepatitis B surface antigen; HEP B SAg = hepatitis B surface antigen pre-52 peptide; HR = heart rate; HSV-1 = herpes simplex virus-1; ISEL = interview schedule for social interaction; IgG = immunoglobulin gamma; KLH = keyhole limpet hemocyanin; LAI = Life Assessment Inventory; MAPS = modifiers and perceived stress; NE = norepinephrine; NK = natural killer; NKCA = natural killer cell activity; PHA = phytohemagglutinin; + = positive; PWM = pokeweed mitogen; rIFN-y = recombinant interferon-gamma; rIL-2 = recombinant interleukin-2; SBP = systolic blood pressure; sIgA = salivary immunoglobulin alpha; SPS = Social Provisions Scale; SSQ = Social Support Questionnaire; TSH = thyroid stimulating hormone; WS = within subjects.
relative balance of immune cells (e.g., ratio of helper T cells to suppressor/cytotoxic T cells) are important in mounting an effective immune response (Herbert & Cohen, 1993b). Functional measures examine the performance of certain immune cells. One common measure is the blastogenic response of lymphocytes to the plant mitogens concanavalin A (Con A) and phytohemagglutinin (PHA). Blastogenesis provides an in vitro model of lymphocyte proliferation in response to antigens. In general, greater proliferation is interpreted as a better immune response. In addition, measures of NK cell lysis are taken by incubating NK cells with a tumor cell line and examining the ability of NK cells to lyse (i.e., destroy) tumor cells. NK cells appear to play an important role in the body's defense against virally infected and malignant cells (Whiteside & Herberman, 1994).

The measurement reliability of immunological data varies across assays and laboratories. Issues such as the day on which the ability of NK cells to lyse (i.e., destroy) tumor cells. NK phytohemagglutinin (PHA). Blastogenesis provides an in vitro model of lymphocyte proliferation in response to antigens. In general, greater proliferation is interpreted as a better immune response. In addition, measures of NK cell lysis are taken by incubating NK cells with a tumor cell line and examining the ability of NK cells to lyse (i.e., destroy) tumor cells. NK cells appear to play an important role in the body's defense against virally infected and malignant cells (Whiteside & Herberman, 1994).

functionality of NK cells may be difficult to determine. Studies that measure multiple aspects of immune function would be in a stronger position to make such conclusions by examining the pattern of immune changes across assays.

We found 19 studies whose researchers examined the association between social support and aspects of immune function (see Table 5). Eight studies used only functional assays, 6 studies only quantitative assays, and 5 studies both quantitative and functional immunological measures. Nine studies were performed with middle-aged or older adult samples (Mage > 40). Nine studies tested both men and women, 6 only women, and 4 only men. In addition, 10 studies were correlational, 7 prospective, and 2 experimental interventions. Of the 17 studies whose researchers assessed naturalistic social support, only 4 included, in part, structural measures of support.

The results of the 19 studies summarized in Table 5 are consistent with the notion that higher social support is associated with better immune system function (e.g., greater NK cell lysis). To summarize, 12 studies' researchers reported evidence that social support was associated with aspects of immune function, and 7 reported no relationship. A meta-analysis of 9 studies whose researchers examined the association between social support and functional immune measures revealed a reliable combined test of significance (z = 4.38, p = .000006, fail-safe n = 54.90). The effect size associated with these studies was r = .21, and no test of variability was significant (p > .49).

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According to psychometric theory, several assessments of an individual across times and situations are likely to provide a more accurate individual difference assessment of immune function. Consistent with this possibility, Fletcher, Klimas, Morgan, and Gjersef (in press) found that the proliferative response to PHA, pokeweed mitogen, and NK cell lysis were characterized by adequate generalizability (G) coefficients (Gs > .70), which increased when assessments were aggregated across times (Gs > .85). Unfortunately, the high costs of immunological assessments make repeated determinations impossible in many circumstances. Although the data obtained by Marsland et al. (1995) and Fletcher et al. suggest that measures of immune response are characterized by good temporal reliability, additional data are needed to examine an individual difference assessment of immune function.6

There are additional issues involved in the interpretation of measures of immune function that may be useful to discuss. As mentioned earlier, there is no single generally accepted measure of immune function. As a result, the interpretation of a single measure of immune function as representing a down regulation may be difficult to determine. Studies that measure multiple aspects of immune function would be in a stronger position to make such conclusions by examining the pattern of immune changes across assays.

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A literature search on PsycLIT (1974–1994) and Medline (1983–1994) crossing the keywords "immune or immunology with psychometrics or reliability" revealed no additional researchers who had examined the temporal stability of the immune assessments discussed in this review.

Our initial search produced 24 studies whose researchers examined the relationship between social support and immune function. We excluded analyses of 6 studies in part or in whole for several reasons. Data on the relationship between social support and white blood cell or total lymphocyte counts were not included in the present review (Arnetz et al., 1983; R. S. Baron, Cutrona, Hicklin, Russell, & Lubaroff, 1990; McIntosh, Kaplan, Kuba, & Landmann, 1993; Thomas, Goodwin, & Goodwin, 1985) because of difficulties in interpreting the significance of these measures. In addition, we excluded 1 study that examined salivary IgA (Jemmott & Magloire, 1988) because of methodological issues regarding the reliability of the salivary IgA assessment that was used in this study (Herbert & Cohen, 1993a; Stone, Cox, Valdimarsdottir, & Neale, 1987). One study was also excluded from the review because the small number of participants (3) in their low stress and no social support cell precluded definitive analyses (Herrera, Alvarado, & Martinez, 1988).
Two of the studies that did not find an association between social support and immunological data were interventions designed to facilitate social interactions (Arnetz et al., 1987; Kiecolt-Glaser et al., 1985). The Kiecolt-Glaser et al. (1985) intervention documented increased social contact and interactions. However, keep in mind that the sample sizes in 2 of these studies are relatively small ($n < 45.00$). In addition, we reviewed evidence earlier suggesting that familial sources of support may be important. It is possible that interventions aimed directly at increasing familial contact and support may yield even larger effects sizes on immune function.

Two of the studies that did not find a significant association between social support and aspects of immune function examined men who were HIV+ (Goodkin et al., 1992; Perry, Fishman, Jacobsberg, & Frances, 1992). There are important methodological reasons that might explain a lack of an association between social support and immune function in individuals HIV+. For instance, stage of disease, age, gender, drug abuse, and health behaviors are potentially important confounding variables (Ironson et al., 1994).

However, 2 recent studies have reported an association between social support and CD4+ counts (a marker of HIV progression) in men with HIV (Persson, Gullberg, Hanson, Moestrup, & Oestergren, 1994; Theorell et al., 1995). In 1 prospective study with data across a 5-year period, Theorell et al. found that the availability of social and emotional support predicted subsequent changes in CD4+ counts in a representative Swedish sample of men with HIV. Results revealed that high and low social support groups did not differ in CD4+ counts during the early years of the study. However, the prediction of CD4+ counts as a function of social support was evident during Years 4 and 5 of the study. For instance, during Year 5 of the study, individuals high in social support showed a $-37\%$ change in CD4+ counts, whereas individuals low in social support showed a $-64\%$ change in CD4+ counts (Theorell et al., 1995). Note that Perry et al. (1992) reported null findings on the relationship between social support and CD4+ counts only up to Year 1 of their study. These preliminary prospective data suggest that social support may influence the progression of HIV infection and provide evidence on the utility of such long-term prospective designs. An important implication of these data is that if a researcher was to only examine the relationship between social support and CD4+ counts later in the stage of disease, information on the longer length of time that individuals high in social support took to get to that stage would be lost.

A population of particular interest in this review is older adults because social support may be especially important for these individuals (House et al., 1988). Alterations in immune function may have significant consequences in this population as aging is associated with a down regulation of immune function (Goold, 1987; Goodwin, Searles, & Tung, 1982; Robert-Thomson, Whittingham, Youngchaiyud, & Mackay, 1974; Schleifer, Keller, Bond, Cohen, & Stein, 1989), and infectious illnesses are the fourth leading cause of death in the elderly (Effros & Walford, 1987). Excluding the intervention studies discussed earlier, it is important to note that the association between social support and functional measures of immunity is consistent in older adults. A meta-analysis of 7 studies in middle-aged to older adult populations confirmed this hypothesis ($z = 4.27, p = .000009, fail-safe n = 40.30$), with an effect size of $r = .23$. No test of variability was significant ($p > .33$).

Although 9 studies' researchers examined both men and women, 8 studies' researchers did not report analyses aimed at examining potential gender differences. In the only study with data on potential gender differences, Thomas, Goodwin, and Goodwin (1985) found that the availability of a confidant was associated with a stronger proliferative response to PHA for women but not men. However, the correlations were in the same direction, and no statistical test was performed to directly test the difference between men and women. In addition, Thomas et al. provided a conservative test of the effects of social support on immune function, as they statistically controlled for psychological distress as well as potential health-related variables (e.g., alcohol consumption).

Similar conceptual issues exist in the research examining social support and immune function as in the research reviewed earlier. Only 2 of the studies summarized in Table 5 conceptualized social support as a multidimensional construct and reported analyses regarding a relatively specific dimension of social support (R. S. Baron et al., 1990; Persson et al., 1994). Although 3 additional studies used multidimensional social support measures, results were only reported on the total scale (e.g., Glaser, Kiecolt-Glaser, Bonneau, Malarkey, & Hughes, 1992; Goodkin et al., 1992; Perry et al., 1992). An examination of relatively distinct dimensions of social support may have revealed greater specificity (Glaser et al., 1992) and stronger associations between social support and immune function (Goodkin et al., 1992; Perry et al., 1992) due to a better match between the sample needs and the support resource.

### Potential Mechanisms Linking Social Support to Immune Function

The studies summarized in Table 5 suggest that social support is associated with better immune function. These results and a recent meta-analysis conducted by Herbert and Cohen (1993a) provide converging evidence for the effects of social support on physiological function. However, Herbert and Cohen only examined aspects of immune function and focused on social stressors involving the loss or disruption of interpersonal resources (e.g., bereavement and marital conflict).

As in the review of social support and cardiovascular function (see Tables 1–3), the studies summarized in Table 5 suggest that close relationships, such as familial ties, may be a particularly important source of social support. Researchers of 2 studies assessed social support specific to close relationships (Levy et al., 1995).
et al., 1990; Thomas et al., 1985), and both found social support to be related to aspects of immune function, including a stronger proliferative response to PHA and greater NK cell lysis.

Researchers of 4 of the studies in Table 5 directly tested the buffering model of social support (Goodkin et al., 1992; Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991; Snyder, Roghmann, & Sigal, 1990, 1993). Of these studies, only Kiecolt-Glaser et al. (1991) reported a reliable effect of stress on immune function. As noted earlier, S. Cohen and Wills (1985) argued that this is a methodological requirement for an adequate test of the buffering model. More important, Kiecolt-Glaser et al. found evidence for a buffering effect of social support on immune function. However, because of the small number of studies, more data are needed to adequately test the buffering model on immune function.

Two of the studies summarized in Table 5 conceptualized social support as a multidimensional construct and reported analyses regarding relatively specific dimension of social support (R. S. Baron et al., 1990; Levy et al., 1990). Levy et al. examined the dimension of emotional support from a spouse (or intimate other) and emotional support from one's doctor and found both to be associated with greater NK cell lysis in cancer patients. In a study of spouses of cancer patients, Baron et al. used the social provisions scale and found that higher levels on all support dimensions (i.e., guidance, reliable alliances, reassurances of worth, social integration, attachment, and opportunity for nurturance) were equally and significantly associated with a stronger proliferative response to PHA and greater NK cell lysis. As noted by Baron et al., caring for a spouse with cancer may result in a mobilization of one's support network, such that there was little differentiation among support components. Consistent with this possibility, Baron et al. reported high intercorrelations among the components of support.

Levy et al. (1990) suggest that emotional support may be one dimension of social support that is associated with immune function. Researchers of 4 additional studies also assessed, in part, emotional support (also see R. S. Baron et al., 1990). Kiecolt-Glaser et al. (1991) and Esterling, Kiecolt-Glaser, Bodnar, and Glaser (1994) used a composite index of emotional and tangible support. Snyder et al. (1990, 1993) used a composite index of emotional and informational support. A meta-analysis of these studies revealed a significant combined test of significance \( z = 4.02, p = .00003, \text{fail-safe } n = 24.90 \). The effect size associated with this test was \( r = .26 \), and no test of variability was significant \( (p > .44) \). These data suggest that emotional support may be at least one important aspect of social support in predicting immune function. Additional research is needed, however, that directly compares the predictive utility of specific dimensions of social support.

At a behavioral level of analysis, part of the association between social support and immune function may be due to their effects on potential health-related variables (Kiecolt-Glaser & Glaser, 1988b). Several researchers assessed the effects of potential health-related behaviors and found that the associations between social support and immune function were significant even when statistically controlling for health practices (Thomas et al., 1985; also see Theorell, Orth-Gomer, & Eneroth, 1990). These data are consistent with results reviewed earlier on social support and blood pressure, suggesting that such behaviors do not appear to be necessary for an association between social support and immune function. However, these findings should be taken as preliminary, given the restricted number of health-related practices assessed and the lack of reported data on the validity and reliability of such assessments in many of these studies.

Psychological factors such as levels of stress and depression have reliable effects on immune function (Herbert & Cohen, 1993a, 1993b). Therefore, part of the association between social support and immune function may be mediated by these factors. Researchers of 3 studies in Table 5 reported data relating to potential psychological mechanisms responsible for the associations between social support and immune function (R. S. Baron et al., 1990; Glaser et al., 1992; Kiecolt-Glaser et al., 1991). Baron et al. (1990) found that the associations between social support and immune function were not mediated by life events. In addition, Baron et al. (1990) and Kiecolt-Glaser et al. (1991) found that depression was not mediating the associations between social support and immune function. Finally, Glaser et al. (1992) reported evidence indicating that anxiety levels were not responsible for the associations between social support and immune function. Therefore, although health-related behaviors, depression, and life stress have reliable effects on aspects of immune function, these factors do not appear to be major pathways explaining the associations between social support and immune function.

Discussion

Social support has been linked to lower rates of morbidity and mortality from diverse disease processes and endpoints. Therefore, the major aims of this review were to examine the evidence linking social support to multiple aspects of physiological function and to characterize the potential mechanisms responsible for these covariations. To the best of our knowledge, this is the first comprehensive review on this topic. The present review indicates that there is relatively strong evidence linking social support to aspects of the cardiovascular, endocrine, and immune systems. These data are consistent with research suggesting that the formation and disruption of social relationships have important immunological and endocrinological sequelae in nonhuman primates and humans (Coe, 1993; Gunnar, 1992; Herbert & Cohen, 1993a). More important, the physiological systems reviewed may play important roles in the leading causes of death in the United States, including cardiovascular disorders, cancer, and respiratory illnesses.10 Conceptual and methodological issues that warrant discussion regarding the C. E. Smith, Fernengel, Holcroft, Gerald, and Marien (1994) conducted a meta-analysis on the effects of social support on various health measures, including physical and stress-related outcomes. They operationalized stress outcomes as reports of negative life events, conflict or distress, and laboratory measures, such as catecholamine levels. Physiological health status was operationalized as subjective states, such as symptoms and signs, and as objective data, such as weight loss, activities of daily living, blood pressure, blood glucose, and reports of sexual activity post hysterectomy. The results of the meta-analyses revealed effect size estimates ranging from .01 to .22. Smith et al. concluded that the relatively small effect sizes suggest that the relationship between social support and health may not be significant or generalizable.

There are several issues that warrant discussion regarding the C. E. Smith et al. (1994) meta-analysis. First, Smith et al. did not present any

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odological issues were also raised regarding the associations between social support and physiological processes. We now turn to these issues.

One basic and recurring issue in the social support literature relates to the measurement of social support (Barrera, 1986; S. Cohen & Wills, 1985; Heitmann & Kaplan, 1988; Orth-Gomer & Unden, 1987; Tardy, 1985; Winemiller et al., 1993). Questions remain about the factor structure of social support and the temporal stability and psychometric properties of such assessments. In the present review, few studies' researchers reported data pertaining to the psychometric properties of their social support measures. Given the heterogeneity in the measures of social support covered in this review, psychometric data may help clarify reliable relationships.

An additional measurement issue concerns the specific sources of social support. The present review indicates that familial ties appear to be an important source of social support to consider in studies of physiological function. Social support researchers might gain greater specificity and prediction by examining specific types of social relationships. The studies summarized in this review whose researchers examined cross-cultural and gender effects of social support are examples of such applications. In addition, behavioral data obtained during laboratory studies may amplify the relationships found between self-report data and physiological processes (e.g., Kiecolt-Glaser et al., 1993; Malarkey, Kiecolt-Glaser, Pearl, & Glaser, 1994).

Most of the studies reviewed in this article have conceptualized social support as a unidimensional construct. As noted earlier, multidimensional assessments may allow for an examination of more specific associations and mechanisms (Uchino, Cacioppo, Malarkey, Glaser, & Kiecolt-Glaser, 1995). For instance, Seeman et al. (1994) found that emotional support was a more consistent predictor of neuroendocrine function than informational support. More important, such specificity would have been lost if an aggregate measure of social support was used. The relative importance of specific dimensions of social support was difficult to characterize in the present review, but consistent with Seeman et al. there was evidence that emotional support has reliable effects on physiological function. Given the conceptual advantages to a multidimensional approach, future researchers might profitably use such an approach and report data on both specific dimensions as well as overall levels of social support.

An important issue examined in the present review relates to the potential psychological mechanisms linking social support to physiological function. A large literature has documented psychological antecedents and consequences of social support (e.g., R. B. Sarason, Sarason, & Pierce, 1989). However, the present review indicates that most studies' researchers have not reported data on such potential mechanisms, and when such data were presented, appropriate statistical procedures for examining mediation and moderation were typically not performed (see R. M. Baron & Kenny, 1986). One interesting preliminary observation is that although health-related behaviors, stressful events, and depression clearly influence physiological processes in their own right, they do not appear to be major pathways by which social support influences physiological function. Future researchers might attempt to characterize the potential psychological mechanisms responsible for the associations between social support and physiological processes based on the larger social support literature (see S. Cohen, 1988).

Prior research on social support processes has been focused on support as a situational variable, however, social support may also be conceptualized as a stable individual differences variable (I. G. Sarason et al., 1986). It is therefore possible that measures of social support may be influenced by personality factors that are correlated with social relationships. As a result, social support may be associated with physiological function through personality processes that influence perceptions of support (Bolger & Eckenrode, 1991). However, consistent with research indicating that social support predicts objective health outcomes, even after statistically controlling for personality factors (House et al., 1988), social support appears to predict physiological function even after statistically controlling for the effects of personality variables or their confounding mechanism (e.g., Kiecolt-Glaser et al., 1991; Uchino et al., 1992; Uchino, Kiecolt-Glaser, & Cacioppo, 1994). Note that personality factors such as neuroticism and extraversion appear to have a larger effect on more subjective measures of health, such as self-reported symptomology (Watson & Pennebaker, 1989). However, the personality dimension of trait hostility is related to objective measures of health (Barefoot, Dahlstrom, & Williams, 1983; Shekelle, Gale, Ostfeld, & Paul, 1983) and appears to have an important interpersonal component (T. W. Smith & Frohm, 1985; T. W. Smith, Pope, Sanders, Allred, & O'Keefe, 1988). Future researchers could profitably examine the interface between social relationships and personologic factors, especially in reference to physical health (McConigle, Smith, Benjamin, & Turner, 1993; T. W. Smith, in press).

In the present review, we have focused on the positive aspects of social relationships. There is a growing body of literature indicating that negative aspects of social relationships are independent of positive aspects of support (Ruehlman & Karoly, 1991) and an important predictor of psychological functioning (Pagel, Erdly, & Becker, 1987; Rook, 1984; Rook & Pietromon...
Sympathetic-adrenergic activation may not only have implications for the development of cardiovascular disorders but may also prime significant coronary events in diseased populations (Kamarck & Jennings, 1991; Krantz et al., 1991; Rozanski et al., 1988). For instance, Krantz et al. (1991) examined stress-induced myocardial ischemia in coronary disease patients. Results revealed that patients with more severe myocardial ischemia during mental stress were characterized by greater SBP reactivity (also see Rozanski et al., 1988). These data are consistent with research indicating that social support also predicts survival after the diagnosis of cardiovascular disorders (e.g., Berkman, Leo-Summers, & Horwitz, 1992).

Activation of a sympathetic-adrenergic mechanism may also influence immune system functioning. Direct sympathetic innervation exists for both primary and secondary lymphoid organs (see review by Felten & Felten, 1991), and lymphocytes have beta-adrenergic receptors (Khan, Sansoni, Silverman, Engleman, & Melmon, 1986; Williams, Snyderman, & Lefkowitz, 1976). More significantly, catecholamines appear to influence aspects of the cellular and humoral immune response (Madden & Livnat, 1991; Sanders & Munson, 1985). In addition, laboratory studies suggest that short-term alterations in immune function to acute psychological stress are largest in individuals showing greater cardiac-sympathetic reactivity (Cacioppo et al., 1995).

It is important to separate the short-term and longer term effects of sympathetic activation because they may have different implications for the effects of social support on the etiology of disease progression. Although the data on this issue are limited, chronic stress may be associated with increased sympathetic activity (Baum, 1990; Irwin et al., 1991) and a down-regulation of beta-adrenergic receptors (Dimsdale, Mills, Patterson, Ziegler, & Dillon, 1994). Such changes appear to be associated with decrements in immune function (Irwin et al., 1991). For instance, Irwin et al. (1991) found elevated levels of a sympathetic neurotransmitter, neuropeptide Y, in caregivers of patients with Alzheimer's disease compared with matched controls and reported that levels of neuropeptide Y were negatively related to NK cell lysis. Given the long-term nature of chronic stress, the repeated activation of a sympathetic-adrenergic mechanism may have relatively long-term effects on the immune system.

In addition to the evidence indicating the importance of sympathetic-adrenergic influences, glucocorticoids have important effects on many aspects of immune function (Cupps & Fauci, 1982). As reviewed earlier, there are important reasons why prior studies may not have found a relationship between social support and tonic cortisol levels. In addition, cortisol reactivity in the form of "acute bursts" may be important in explaining variance between social support and health. Consistent with this reasoning, preliminary data from our laboratory suggest that cortisol reactivity to acute psychological stress predicted older adult reactions to an influenza vaccination (i.e., influenza virus induced interleukin-2 levels in vitro) given 7 to 8 months earlier (see Cacioppo, 1994). To date, little idiographic data exist on the influence of social support on cortisol reactivity to acute psychosocial stressors. In addition, an examination of receptor functioning may prove helpful in obtaining an integrated understanding of not only the association between social support and hormones of the hypothalamic-pituitary-adrenal axis (Seeman & Robbins, 1994) but also hormones of the SAM (Mills & Dimsdale, 1993). Future research will help to understand the potential impor-
tance of examining specific patterns of sympathetic–adrenergic activity (Cacioppo et al., 1992). For instance, research on neuroendocrine–immune interactions during acute psychological stress suggests that cardiac–sympathetic reactivity, as assessed by pre-ejection period, appears to be closely linked to activation of the HPA, whereas catecholamines do not appear to operate through such a mechanism (Cacioppo et al., 1995; Manuck, Cohen, Rabin, Muldoon, & Bachen, 1991; Spoutas-Ermch et al., 1994; Uchino, Cacioppo, Malarkey, & Glaser, 1995). Research designs that incorporate assessments across the cardiovascular, endocrine, and immune systems may help elucidate more specific pathways responsible for the effects of social support across physiological processes. To this point, it should be noted that of the 81 studies reviewed in this article, only 5 obtained simultaneous measures from two of the different physiological systems (e.g., cardiovascular and endocrine) and that none of the studies obtained measures across all three systems. It is also noteworthy that there is a surprising dearth of research on social support and neuroendocrine processes in humans. The neuroendocrine system almost certainly serves as an important gateway between personal relationships and health; even daily psychological stressors can provoke the release of pituitary and sympathetic adrenomedullary hormones that have multiple effects, including alterations in the cardiovascular and immune systems (e.g., Cacioppo et al., 1995; Malarkey et al., 1994).

We should note that unidimensional conceptualizations of physiological processes may be at least as significant an obstacle to illuminating the mechanisms underlying the health benefits of social support, as are unidimensional conceptualizations of social support. Cardiovascular reactivity, for instance, has tended to be treated as a unidimensional (and occasionally as a unidirectional) construct ranging from low to high, reflecting individual differences in adrenergic reactivity to daily stressors and behavioral challenges. Although adrenergic activity exerts predominant control over the vasculature and cardiac inotropy, cardiac chronotropy (and, thus, cardiac output) is a joint function of sympathetic and vagal activity. Moreover, vagal as well as sympathetic influences on the heart are evident both at rest and in response to daily tasks, challenges, and stressors (e.g., M. T. Allen & Crowell, 1989; Grossman, Stemmler, & Meinhardt, 1990; see reviews by Cacioppo, 1994; and Porges, 1992), and the vagal and sympathetic outflows to the heart can vary reciprocally, non-reciprocally (e.g., coactivation), or independently (Bernston, Cacioppo, & Quigley, 1991, 1993; Cacioppo, Uchino, & Bernston, 1994). An individual's classification as high in cardiovascular reactivity ignores possible individual differences in the autonomic origins of this reactivity. Variations in the autonomic origins of cardiovascular reactivity have generally been relegated to the error term, a practice that has obscured relationships between autonomic, endocrine, and immune responses and may obscure relationships between autonomic processes and social, behavioral, or health outcomes.

As the case for heart rate, similar conceptual issues relate to the assessment of blood pressure. Blood pressure is a function of both cardiac output and peripheral resistance. Recent research has demonstrated considerable individual differences in the underlying mechanisms of blood pressure responses (Kasprowicz, Manuck, Malkoff, & Krantz, 1990; Sherwood, Dolan, & Light, 1990). A specifiable subset of individuals achieve blood pressure changes primarily through vascular mechanisms (i.e., peripheral resistance), whereas a different subset of individuals achieve comparable blood pressure changes primarily through hemodynamic mechanisms (i.e., cardiac output). The impedance cardiograph (see Sherwood, Allen, et al., 1990) provides noninvasive estimates of cardiac output and total peripheral resistance and should prove useful in future investigations of the underlying basis of both tonic and phasic blood pressure.

We have focused on the cardiovascular, endocrine, and immune systems as potential windows through which to examine the long-term health consequence of social relationships. The intervention studies examining hypertensive patients provide data to show how social support could have important health consequences. Animal models have demonstrated the predictive utility of cardiovascular reactivity in the development of cardiovascular disorders (Folkow et al., 1973; Hallbeck & Folkow, 1974; Manuck et al., 1983). Less is known, however, about the long-term effects of heightened cardiovascular reactivity in humans, although supportive evidence is mounting (e.g., Light et al., 1992; Manuck, 1994). Research on social support in at-risk populations and continued theoretical development in the reactivity literature may help to clarify the link between cardiovascular function and physical health.

Similarly, animal models have demonstrated the importance of alterations in the endocrine and immune systems on infections and tumor growth (Habu, Akamatsu, Tamaoki, & Okumura, 1984; Lewis et al., 1983; Sheridan, Feng, Bonneau, Malarkey, & Hughes, 1991). In addition, some studies have linked alterations in immune function with various health consequences in humans (Cohen, Stevens, Cohen-Cole, Kirk, & Freeman, 1982; Fletcher, Baron, Ashman, Fischl, & Klimas, 1987; Kiecolt-Glaser & Glaser, 1995; Lumio, Welin, Hirvonen, & Weber, 1983; Murasko, Weiner, & Kaye, 1988), including cancer, infectious illness, and HIV progression. Future studies on social support and physiological processes that include measures of physical health status would be helpful in clarifying the links to actual health outcomes.

As noted by House et al. (1988), the effects of social support on health may be particularly important for older adults:

Changes in marital and childbearing patterns and in the age structure of our society will produce in the 21st century a steady increase in the number of older people who lack spouses or children—the people to whom older people often turn for relatedness and support. Thus, just as we discover the importance of social relationships for health, and see an increasing need for them, their prevalence and availability may be declining. (p. 544)

Chronological aging is typically associated with changes in the cardiovascular (Uchino et al., 1992) and endocrine systems (Meites, Goya, & Takahashi, 1987), a down regulation of the immune system (Burns & Goodwin, 1990), and declines in physical health (Effros & Walford, 1987; Kart, Metress, & Mettress, 1992). Therefore, alterations in these compromised physiological systems may have significant health consequences in older populations. More important, the studies summarized in this review are consistent with the notion that social support
may moderate such physiological processes in older adults. Given the importance of close affective social bonds in these adults (Antonucci & Akamaya, 1987; Carstensen, 1992) and impending demographics shifts that may curtail the availability of familial sources of support, facilitating the development of close emotional bonds among them may be particularly important.

The studies summarized in this review may have relevance for the aging process more generally. Research on chronological age and physiological function suggests that such physiological changes are not a biological invariant with aging (E. L. Smith, 1984) and that social factors may play a role in the aging process (Sztklo, 1979; Uchino et al., 1992). The results of this review suggest that social support has beneficial effects on physiological processes across different age groups. The net effect of such processes may be to biologically age the individual at a slower rate. Consistent with this hypothesis, we have found that social support predicts age-related differences in blood pressure. More specifically, individuals low in social support were characterized by age-related increases in blood pressure, whereas individuals high in social support were characterized by low and comparable blood pressure across the ages (Uchino et al., 1992; Uchino, Cacioppo, Malarkey, Glaser, & Kiecolt-Glaser, 1995).

In conclusion, understanding what precisely are the relationships between social support and health outcomes in specific populations will likely change as refinements are made in the conceptualization and assessment of theoretical constructs, such as social support, construals and coping responses, behaviorally relevant physiological events, and so on. As research moves from a description of associations to a delineation of underlying mechanisms, questions of causative factors take on added importance. Considerable research exists, for instance, demonstrating that neurochemical events can influence social processes and that social processes influence neurochemical events. Studies of mating behavior in the ring-necked dove indicate that social behaviors (e.g., male strutting and cooing) trigger hormonal changes (e.g., increased production of estrogen in the female dove), which predisposes the female toward a new set of behaviors (e.g., courtship and copulation), which results in additional reciprocal influences between hormones and social behaviors until the newborns are reared (Erikson & Lehrman, 1964; Lehrman, 1964; Martinez-Vargas & Erikson, 1973). Reciprocal influences between social and physiological events have been found in primates, as well. Testosterone levels in male primates, for example, have been found to promote sexual behavior, whereas the availability of sexually receptive females, in turn, has been found to influence testosterone levels in male primates (Bernstein, Gordon, & Rose, 1983; Bernstein, Rose, & Gordon, 1974; Rose, Gordon, & Bernstein, 1972; see Cacioppo & Berntson, 1992). Indeed, understanding the function of hormones may have been far more rudimentary if not for analyses of their effects on social behavior and for the effects of social behavior on hormonal changes. There are, of course, physiological mechanisms underlying these phenomena, but the identification and understanding of these mechanisms are better served by systematic investigations within and across multiple levels of analysis rather than by an exclusive focus on any one level of analysis. Thus, the research reviewed here specifies a set of associations in need of mechanistic explanations but represents only the first wave of research describing associations between social processes and health.

References


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Persson, I., Gullberg, B., Hanson, B. S., Moestrup, T., & Ostergren,


