ORIGINAL RESEARCH

Yoga for Improving Sleep Quality and Quality of Life for Older Adults

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ABSTRACT

Context • The aging process is associated with physiological changes that affect sleep. In older adults, undiagnosed and untreated insomnia may cause impaired daily function and reduced quality of life (QoL). Insomnia is also a risk factor for accidents and falls that are the main cause of accidental deaths in older adults and, therefore, is associated with higher morbidity and mortality rates in older populations.

Objectives • The research team aimed to (1) examine the efficacy of a yoga intervention (YI) for the treatment of insomnia in older adults, (2) determine the ability of yoga to enhance the QoL of older adults, and (3) establish the applicability of yoga practice for older people in a Western cultural setting.

Design • A waiting-list controlled trial.

Settings • The study took place in Jerusalem, Israel, from 2008-2009.

Participants • Participants were older men and women (age ≥ 60 y) with insomnia.

Intervention • The YI group participated in 12 wk of classes, held 2 ×/wk, incorporating yoga postures, meditative yoga, and daily home practice of meditative yoga.

Outcome Measures • The study used self-report assessments of sleep quality using the following: (1) sleep quality—the Karolinska Sleepiness Scale (KSS), the Epworth Sleepiness Scale (ESS), and the Pittsburgh Sleep Quality Index (PSQI), and daliy sleep and practice logs; (2) mood states—the Depression Anxiety Stress Scale long form (DASS-42) and the Profile of Mood States short form (POMS-SF); (3) a health survey (SF-36); and (4) mobile at-home sleep studies.

Results • Compared with controls, the YI group showed significant improvements in a range of subjective factors, including overall sleep quality; sleep efficiency; sleep latency and duration; self-assessed sleep quality; fatigue; general well-being; depression; anxiety; stress; tension; anger; vitality; and function in physical, emotional, and social roles.

Conclusions • Yoga was shown to be safe and improved sleep and QoL in a group of older adults with insomnia. Outcomes depended on practice compliance. (*Altern Ther Health Med.* 2014;20(3):37-46.)

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The aging process is associated with physiological changes that affect sleep.[1] Diminished, subjective sleep quality is one of the most frequent health complaints in older adults,[2] with more than 80% experiencing some sleep disturbance and 50% reporting frequent occurrence of sleep disturbance.[3]

In older adults, undiagnosed and untreated insomnia may cause impaired daily function and reduced quality of life (QoL). Insomnia is also a risk factor for accidents and falls[4-8] that are the main cause of accidental death in older adults[9] and, therefore, is associated with higher morbidity and mortality rates in older populations.[4,10]

Sleep disturbances are also associated with an increased likelihood of nursing-home placement and often influence family members' decision to move an older adult into a care facility for the aged.[11,12] Taken together, these findings emphasize the importance of addressing insomnia in older adults.

Benzodiazepines are currently the preferred pharmacologic intervention for insomnia,[13] but their use is associated with adverse events.[14] Existing data support only short-term use.[14-18] Nonpharmacological interventions may provide a safe alternative to hypnotics, and studies have shown an increase in the use of complementary and alternative medicine therapies, such as deep breathing, meditation, yoga, progressive muscular relaxation, and guided imagery, to address issues such as anxiety, depression, and insomnia.[19]

Yoga provides a holistic approach toward mind and body and addresses physical, mental, and spiritual well-being through diverse psychophysical practices that may include physical exercises, breathing exercises, relaxation practices, and meditation practices.[20] Studies have shown that yoga can improve subjective sleep quality in patients with chronic insomnia,[21] cancer patients,[22] and women with comorbid osteoarthritis and insomnia.[23] Yoga has also been found to reduce both subjective and objective insomnia symptoms in postmenopausal women.[24] Furthermore, studies have shown that yoga practices can improve some measures of subjective sleep quality and QoL in older adults.[25-28]

The aim of the present study was to evaluate whether a simple, integrated yoga intervention (YI), with a home-based meditation component, could improve both the subjective and the objective sleep qualities and QoL of older people living in a Western cultural setting.

MATERIALS AND METHODS

Participants

The study was conducted from March 2008 to February 2009 at Shaare Zedek Medical Center (SZMC), a primary health care center in Jerusalem, Israel, in collaboration with the School of Health Sciences at the Royal Melbourne Institute of Technology (RMIT) in Australia. The study was approved by the ethics committees of RMIT and SZMC, and subjects gave informed consent for their participation in the study.

Participants were recruited via an advertising campaign throughout the greater metropolitan area of Jerusalem. Inclusion criteria specified older men and women (age ≥ 60 y) presenting with complaints about insomnia, as described in the diagnostic criteria of the *Diagnostic and Statistical Manual of Mental Disorders-IV* (*DSM-IV*), who were willing and able to give informed consent and to comply with all of the study's protocols and procedures. The screening process was designed to exclude individuals suffering from psychological and/or medical conditions known to affect sleep and/or mental states. The study followed current clinical guidelines[29-32] regarding patients complaining about insomnia. Accordingly, insomnia was diagnosed by a clinical evaluation based on a systematic review of medical and psychiatric status, a determination that patients were not involved in substance abuse, and a sleep history acquired by interviews with sleep physicians at SZMC. Participants' medical records were also reviewed. Participants included in the study were permitted to continue with any medication they reported during the screening phase, including sleep-related medication, but were requested not to start sleep medication or engage in other forms of yoga, meditation, or similar activities during the study. They were also asked to report any changes in their medical status or medications immediately to the study's physician.

The advertising campaign resulted in 458 candidates in a period of 6 months. The screening and admission process included an initial phone interview, a review of medical forms, an examination by a sleep physician, and a signing of consent forms. A total of 74 suitable applicants were admitted to the study. All other applicants were excluded because they did not meet all inclusion criteria or because they declined to participate and/or sign consent forms. Please refer to the study's CONSORT flowchart (Figure 1).

The first 31 patients were assigned to the waiting-list control (WLC) group, and the following 43 were assigned to the YI group. The WLC participants were informed at the outset that they would have an opportunity to participate in YI sometime after the control phase. After completing the 12-week control phase, WLC participants were contacted and offered YI. Fifteen participants declined the offer, citing an inconvenient location and/or timing because of changes in daily/weekly schedules and/or life circumstances. Sixteen participants accepted the offer. These 16 were also assigned to the YI group. Therefore, the YI group included a total of 59 participants.

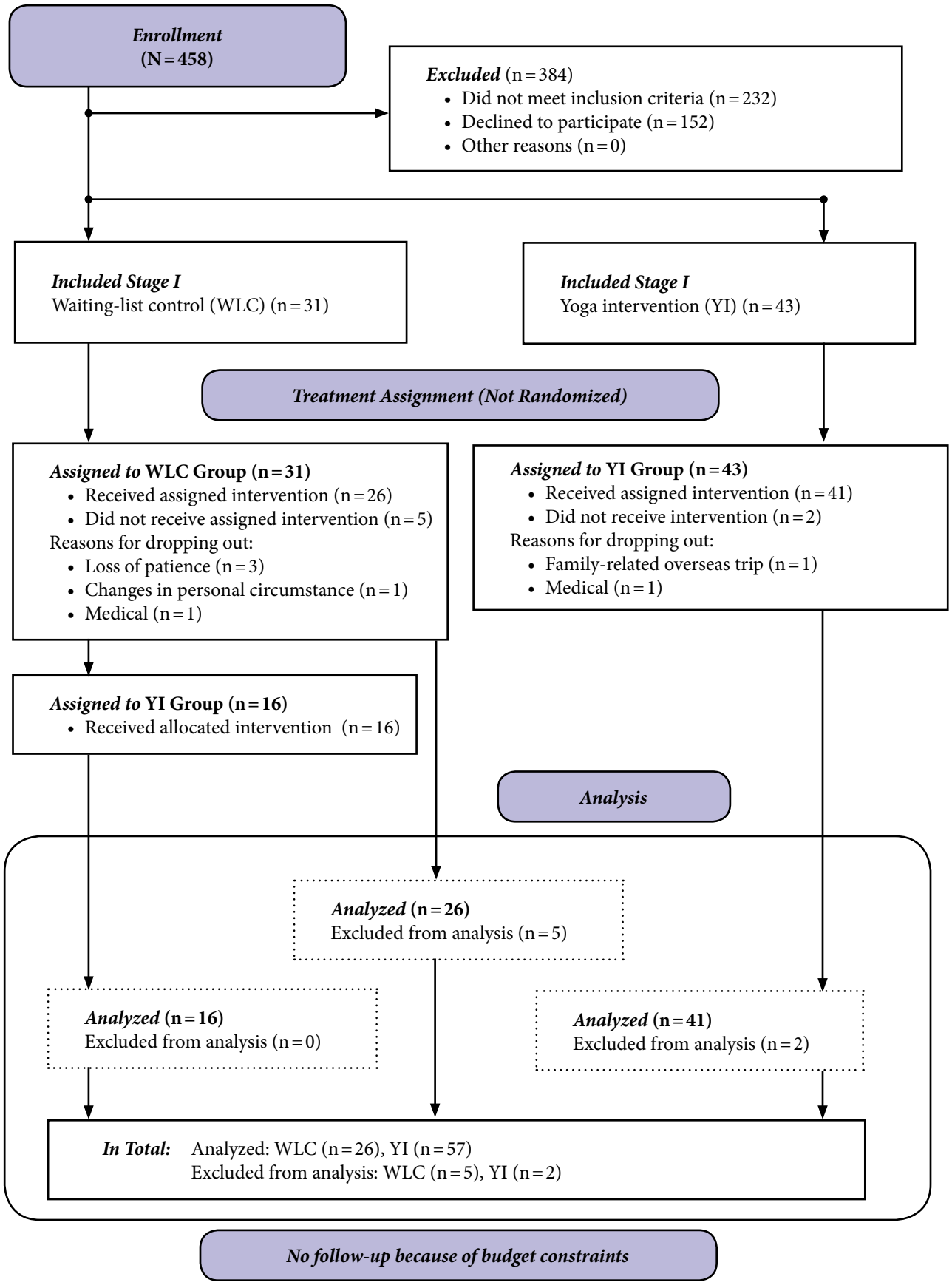
A total of 7 participants dropped out (5 from the WLC group and 2 from the YI group). Five dropped out for personal or family reasons, and 2—1 from the WLC group and 1 from the YI group—dropped out for health reasons unrelated to the intervention.

Experimental Protocol

The study was designed as a nonrandomized, waiting-list controlled trial. The YI group participated in 12 weeks of yoga classes, meeting twice weekly, with recommended, daily, home-based practice. The classes were conducted by 6 hatha yoga teachers certified by the Israel Yoga Teachers Association. Classes were held in suitable public venues that normally were used for conducting similar activities and that had all the necessary equipment, including mats, chairs, first-aid equipment, and medivac access. The number of participants per class was kept below 25 to ensure safety.

The yoga classes included both yogic asanas (postures) and meditative yogic practices. The asanas component included standing, sitting, prone, and supine yoga postures designed to improve body awareness, balance, flexibility, and mobility. The meditation and relaxation protocol consisted of 3 basic meditative exercises designed to facilitate the development of mind-body skills including breath awareness, sensory awareness, concentration, and relaxation. These exercises included a yogic breath-counting meditation; a guided, yogic, body relaxation exercise; and a sequence of yoga *nidra* ("yogic sleep" in Sanskrit), a deep relaxation and meditation technique that brings the body to a state of rest and the mind to a state of heightened awareness. The home practice consisted of the same 3 meditative yogic exercises

Figure 1. CONSORT Flowchart



used in class, which were recorded on an audio CD. Home practice did not include yoga postures for safety reasons. Upon joining, participants were asked to attend all classes and achieve an overall level (in class and at home) of 3 practice units per day (eg, 3 home units of exercise or 1 class and 2 home units of exercise).

Outcome Measures

Demographic data were obtained at baseline. Both subjective and objective instruments were used to measure the study's outcomes.

Participants completed the subjective outcome measures within the 10 days prior to the intervention (baseline) and again within the 10 days after the intervention (postintervention). Subjective measures were derived from a range of self-report, validated questionnaires, eliciting information on sleep quality and disturbances and daytime sleepiness and function, using (1) the Pittsburgh Sleep Quality Index (PSQI), (2) the Karolinska Sleepiness Scale (KSS), (3) the Epworth Sleepiness Scale (ESS), and (4) daily sleep and practice logs.

PSQI. A self-rate questionnaire designed specifically to measure sleep quality and sleep disturbances in clinical populations, the PSQI asks subjects to rate sleep quality and disturbances in the month preceding test administration. The PSQI yields various subjective scores including sleep duration, latency, efficiency, disturbances, sleep medication, subjective sleep quality, and daily dysfunction.

KSS. The KSS is a simple, frequently used self-rate questionnaire for evaluating current subjective sleepiness. It asks the respondent, "How sleepy are your right now?" using a scale of 1 to 9.

ESS. The ESS is a short self-rate questionnaire shown to provide a general level of daytime sleepiness. It asks the respondent to rate the likelihood of falling asleep in 8 different common daily life situations.

Daily Sleep and Practice Logs. These self-report logs are designed for collecting information about daily sleep and wake patterns, eating patterns, yoga practice patterns, and use of hypnotics and relaxants. The data were also used in conjunction with class attendance records to calculate participants' compliance with treatment.

The study also used measures of psychological and physical well-being and daily and social functioning, including (1) the Profile of Mood States short form (POMS-SF); the Depression Anxiety Stress Scale long form (DASS-42); and a health survey, short form 36 (SF-36).

POMS-SF. A psychological test designed to measure a person's transitory mood/emotional states, the POMS-SF measures tension, depression, anger, fatigue, confusion, and vigor.

DASS-42. The DASS-42 is a self-report questionnaire designed for both research and clinical applications. It consists of 3 separate scales that measure negative emotional states, including depression, anxiety, and stress.

SF-36. The SF-36 is a multipurpose, short-form, self-report health survey for measuring health status, comparing the relative burden of diseases and differentiating health benefits from a wide range of interventions. It measures physical health; mental health; general health; pain; vitality; physical, emotional, and social functioning; and ability to carry out tasks involving emotional and physical roles.

Objective measures were derived from data recordings acquired during overnight sleep studies before and after the intervention period. Portable Embletta X100 sleep-monitoring devices (Embla Systems, Ontario, Canada), which are compliant with the American Academy of Sleep Medicine's recommendations for portable monitoring, were connected at the medical center before sending participants home to sleep. Basic insomnia-related measures extracted from the data included sleep onset latency (SOL), total sleep time (TST), and total wake time after sleep onset (WASO), as well as basic sleep-staging measures that included the latency and duration of the light sleep (LS), rapid eye movement (REM) sleep, and slow-wave sleep (SWS) stages.

SOL. SOL is the period measured from bedtime to the beginning of first stage of sleep (either REM or non-REM sleep).

TST. TST is the total amount of actual sleep time in a sleep period equal to TST minus WASO. TST consists of the total of all REMs and non-REMs (NREMs) in a sleep period.

WASO. WASO is the total time that a person is in a wakeful state between SOL and the final wake-up time.

REM Sleep. REM sleep is the rapid eye movement sleep stage in which dreams normally occur.

NREM Sleep. NREM sleep includes all non-REM sleep stages.

LS. LS includes all sleep stages that are both non-SWS and NREM.

SWS. SWS is the slow-wave sleep stage, considered the deepest sleep stage in which significant physiological maintenance may occur.

Note that latency of any sleep phase indicates the period measured from SOL to the first appearance of that particular sleep stage during the night. Furthermore, duration of any sleep phase is the total periods that a person has spent in that particular sleep stage during the night from the initial SOL until the final awakening.

Adverse events were noted by the yoga teachers in the class attendance logs and by participants in their daily logs and were reported to the study's physician. Class attendance was noted in the class attendance logs. The number of completed home practice exercises was noted daily by participants in the daily logs.

A global practice compliance score based on total standardized practice units, class and home, was calculated and expressed in practice units per day. A complete, single, home-based exercise or a single yoga class was scored as 1 practice unit (25 min net practice).

Statistical Methods

The main statistical method was a mixed, repeated measure analysis of variance (ANOVA). The between-subjects

factor was group and the within-subjects factor was time (preintervention/control phase vs postintervention/control phase). Two types of comparisons were made. The main comparison compared the YI group with the WLC group. The second compared high-compliance YI participants in a subset group (YHC) with low-compliance YI participants in a second subset group (YLC) and with controls. The YHC and YLC groups were derived postintervention from daily practice and class attendance logs that were used to determine individual compliance levels. A median compliance-level split was used to create the YHC and YLC groups.

The subjective and objective dependent variables measured pre- and postintervention were subjected to the tests of the assumptions underlying ANOVA. To test the assumptions of normality, all data were subjected to visual inspections of frequency distributions and also Kolmogorov-Smirnov and Shapiro-Wilk tests of normality.

The global (ie, summary) scores of the PSQI, POMS, DASS-42, and SF-36 scales were used to assess the clinical significance of the results. For each of these summary scores, a clinically significant improvement compared with the baseline global score was scored for an improvement with $P \leq .05$. Similarly, a clinically significant deterioration compared with the baseline global score was scored for a deterioration with $P \leq .05$. All other results were not considered clinically significant.

RESULTS

Demographics

A total of 67 participants completed the study. All groups and subset groups were demographically similar. Table 1 summarizes participant demographics.

Dropouts, Compliance, and Safety

The safety of the yoga protocol was evaluated by monitoring adverse events. As shown in Table 1, the dropout rate was low (3.4% of the YI group). However, compliance in general, and home practice compliance in particular, were below recommended levels. Mean class attendance, expressed as a percentage of classes attended, was 63.7% (SD = 30.6%) and mean overall practice compliance, expressed in practice units, was 1.34 (SD = 1.54). Only 10% of participants achieved an overall practice compliance level equal to or higher than the recommended level. The median compliance level, used to derive the YHC and YLC groups, was 0.96—close to 1 practice unit per day or 25 minutes of net practice per day. No adverse events occurred related to yoga practice.

Table 1. Demographic Characteristics of WLC, YI, YLC, and YHC Groups

	Control	YI	YI Subsets	
			YLC	YHC
Characteristics	n = 31	n = 59	n = 29	n = 30
Age, y	M = 71.26 SD = 6.77	M = 74.66 SD = 7.39	M = 75.14 SD = 6.67	M = 74.20 SD = 8.11
Gender				
Female	26 (84%)	48 (81%)	25 (86%)	23 (77%)
Male	5 (16%)	11 (19%)	4 (14%)	7 (23%)
Marital Status				
Married	16 (52%)	27 (45%)	13 (45%)	13 (43%)
Single/widowed	15 (48%)	32 (55%)	16 (55%)	17 (57%)
Dropouts	5 (16%)	2 (3 %)	2 (7%)	0 (0%)

Abbreviations: WLC = waiting-list control; YI = yoga intervention; YLC = YI low-compliance subset; YHC = YI high-compliance subset; M = mean; SD = standard deviation.

Sleep Quality

Overall, significant improvements were found in many subjective measures for the YI group but not for the WLC group. Significant improvement also occurred for the YHC group compared with the YLC group. Specifically, significant improvements were found in the YI group but not in the WLC group in the subjective measures of sleep efficiency ($P = .045$ vs $P = .24$), sleep duration ($P = .042$ vs $P = .17$), and sleep quality ($P = .002$ vs $P = .44$). Significant improvements were seen in subjective measures of sleep latency for both the WLC ($P = .004$) and YI ($P = .012$) groups. Significant improvements were found in the YHC group but not in YLC group in subjective measures of sleep efficiency ($P = .012$ vs $P = .83$), sleep duration ($P < .001$ vs $P = .41$), and sleep quality ($P = .012$ vs $P = .076$). In contrast, no other significant changes were seen in any of the objective measures, except for an increase of 11.5% only in the YHC group in SWS duration ($P = .042$) .

In summary, the results show that YI resulted in improvement in most aspects of subjective sleep quality and in the duration of SWS in subjects with high compliance. Tables 2 and 3 summarize these results. The discrepancy between subjective and objective findings is discussed below.

QoL

Overall, significant improvements were found in many QoL measures in the YI group but not in the WLC group and in the YHC versus the YLC group. Specifically, significant improvements were found in the YI group but not in the WLC group in the global scores of the DASS-42 ($P = .010$ vs $P = .21$), the POMS ($P = .009$ vs $P = .18$), and the SF-36 ($P = .008$ vs $P = .87$). The study found similar significant differences in the mental and physical health subscales. Compared with the WLC group, the YI group saw improvements in DASS-42 depression ($P = .019$ vs $P = .56$), DASS-42 stress ($P = .020$ vs $P = .25$), POMS fatigue ($P = .010$ vs $P = .84$), SF-36 physical-role function ($P = .035$ vs $P = .26$), SF-36 vitality ($P = .053$ vs $P = .37$), and S-F36 social function ($P = .030$ vs $P = .13$). Furthermore, significant improvements were found in the YHC group but not in YLC group in the global scores of the DASS-42 ($P = .002$ vs $P = .71$), POMS ($P = .014$ vs $P = .24$), and SF-36 ($P = .030$ vs $P = .13$), as well as in the following mental and physical health subscales: DASS-42 depression ($P = .003$ vs $P = .83$), DASS-42 stress ($P = .008$ vs $P = .59$), DASS-42 anxiety ($P = .011$ vs $P = .96$),

Table 2. Subjective Sleep Quality Pre- and Postintervention Results

Variable	Group	Subset Groups	n	Preintervention M (SD)	Postintervention M (SD)	*df*	*P* Value
PSQI Global Score							
	WLC		21	10.14 (3.21)	10.00 (3.08)	1.64	.81
	Total YI		45	9.82 (3.49)	8.67 (3.62)	1.64	.011
	YI subsets	YLC	18	9.17 (3.94)	9.72 (4.03)	1.63	.39
		YHC	27	10.26 (3.14)	7.96 (3.22)	1.63	<.001
PSQI Sleep Quality Score							
	WLC		25	1.84 (0.62)	1.72 (0.54)	1.78	.44
	Total YI		55	1.60 (0.65)	1.27 (0.52)	1.78	.002
	YI subsets	YLC	25	1.56 (0.71)	1.28 (0.46)	1.77	.076
		YHC	30	1.63 (0.61)	1.27 (0.58)	1.77	.012
PSQI Sleep Latency Score							
	WLC		22	2.45 (0.67)	2.00 (0.93)	1.62	.012
	Total YI		42	1.86 (0.98)	1.48 (1.02)	1.62	.004
	YI subsets	YLC	17	1.94 (1.03)	1.82 (1.07)	1.61	.56
		YHC	25	1.80 (0.96)	1.24 (0.93)	1.61	.001
PSQI Sleep Duration Score							
	WLC		23	2.04 (0.82)	2.26 (0.75)	1.73	.17
	Total YI		52	2.00 (0.99)	1.77 (0.85)	1.73	.042
	YI subsets	YLC	23	1.74 (1.10)	1.87 (0.87)	1.72	.41
		YHC	29	2.21(0.86)	1.69 (0.85)	1.72	<.001
PSQI Sleep Efficiency Score							
	WLC		14	1.50 (1.29)	1.86 (1.10)	1.53	.24
	Total YI		41	1.41 (1.22)	1.05 (1.09)	1.53	.045
	YI subsets	YLC	18	1.28 (1.23)	1.22 (1.00)	1.52	.83
		YHC	23	1.52 (1.24)	0.91 (1.16)	1.52	.012
PSQI Sleep Disturbance Score							
	WLC		22	1.27 (0.46)	1.27 (0.63)	1.70	1.00
	Total YI		50	1.34 (0.56)	1.26 (0.49)	1.70	.35
	YI subsets	YLC	21	1.24 (0.54)	1.33 (0.48)	1.69	.47
		YHC	29	1.41 (0.57)	1.21 (0.49)	1.69	.066
PSQI Sleep Medication Score							
	WLC		26	1.77 (1.18)	1.73 (1.15)	1.79	.82
	Total YI		55	1.38 (1.41)	1.33 (1.41)	1.79	.64
	YI subsets	YLC	25	1.44 (1.39)	1.40 (1.41)	1.78	.82
		YHC	30	1.33 (1.45)	1.27 (1.48)	1.78	.68
PSQI Sleep Dysfunction Score							
	WLC		24	0.92 (0.58)	0.88 (0.68)	1.72	.80
	Total YI		50	0.80 (0.76)	0.74 (0.63)	1.72	.60
	YI subsets	YLC	22	0.91 (0.81)	0.95 (0.65)	1.71	.79
		YHC	28	0.71 (0.71)	0.57 (0.57)	1.71	.35

Abbreviations: PSQI = Pittsburgh Sleep Quality Index; WLC = waiting-list control; YI = yoga intervention; YLC = yoga low-compliance subset group; YHC = yoga high-compliance subset group; M = mean; SD = standard deviation; *df* = degrees of freedom.

Table 3. Pre- and Postintervention Results for SWS Duration[a]

Group	Subset Groups	n	Preintervention M (SD)	Postintervention M (SD)	*df*	*P* Value
WLC		23	106.74 (24.80)	107.44 (20.70)	1.68	.92
Total YI		47	106.49 (28.00)	112.34 (30.92)	1.68	.26
YI subsets	YLC	20	106.25 (24.59)	101.25 (23.64)	1.67	.52
	YHC	27	106.67 (30.75)	120.56 (33.45)	1.67	.042

[a]Measured in minutes.

Abbreviations: SWS = slow-wave sleep; WLC = waiting-list control; YI = yoga intervention; YLC = yoga low-compliance subset group; YHC = yoga high-compliance subset group; M = mean; SD = standard deviation; *df* = degrees of freedom.

Table 4. Pre- and Postintervention Results for QoL

Variable	Group	Subset Groups	n	Preintervention M (SD)	Postintervention M (SD)	*df*	*P* Value
DASS-42 Global Score							
	WLC		21	23.48 (23.30)	19.86 (16.28)	1.71	.21
	Total YI		52	21.87 (17.32)	17.06 (14.03)	1.71	.010
	YI subsets	YLC	23	20.04 (19.21)	19.04 (13.08)	1.70	.71
		YHC	29	23.31 (15.86)	15.48 (14.77)	1.70	.002
DASS-42 Depression Score							
	WLC		21	6.00 (6.86)	5.38 (5.43)	1.72	.56
	Total YI		53	5.34 (6.23)	3.74 (4.75)	1.72	.019
	YI subsets	YLC	24	5.08 (7.41)	4.88 (5.91)	1.71	.83
		YHC	29	5.55 (5.18)	2.79 (3.34)	1.71	.003
DASS-42 Anxiety Score							
	WLC		22	7.00 (6.60)	6.68 (5.80)	1.76	.73
	Total YI		56	7.07 (5.72)	5.96 (4.96)	1.76	.060
	YI subsets	YLC	26	6.19 (5.64)	6.15 (4.10)	1.75	.96
		YHC	30	7.83 (5.78)	5.80 (5.67)	1.75	.011
DASS-42 Stress Score							
	WLC		22	10.50 (11.08)	8.91 (7.65)	1.73	.25
	Total YI		53	9.53 (7.90)	7.43 (7.27)	1.73	.020
	YI subsets	YLC	24	8.71 (7.86)	8.00 (7.13)	1.72	.59
		YHC	29	10.21 (8.01)	6.97 (7.48)	1.72	.008
POMS Global Score							
	WLC		19	16.16 (25.65)	11.21 (20.86)	1.64	.18
	Total YI		47	11.96 (19.10)	5.68 (13.58)	1.64	.009
	YI subsets	YLC	21	10.05(17.27)	5.90 (12.46)	1.63	.24
		YHC	26	13.50 (20.67)	5.50 (14.65)	1.63	.014
POMS Depression Score							
	WLC		21	4.67 (6.37)	4.10 (4.71)	1.68	.48
	Total YI		49	3.47 (4.11)	2.35(3.24)	1.68	.037
	YI subsets	YLC	22	3.18 (4.33)	2.18 (3.98)	1.67	.21
		YHC	27	3.70 (4.00)	2.48 (2.56)	1.67	.09
POMS Tension Score							
	WLC		22	6.14 (7.03)	5.41 (4.50)	1.69	.45
	Total YI		49	5.29 (4.86)	4.24 (4.09)	1.69	.11
	YI subsets	YLC	23	4.52 (4.73)	4.35 (3.20)	1.68	.85
		YHC	26	5.96 (4.97)	4.15 (4.81)	1.68	.044
POMS Anger Score							
	WLC		20	4.70 (4.93)	5.15 (4.16)	1.67	.52
	Total YI		49	4.33 (4.20)	3.24 (3.00)	1.67	.073
	YI subsets	YLC	23	3.48 (3.62)	3.17 (2.62)	1,66	.64
		YHC	26	5.08 (4.59)	3.31 (3.35)	1.66	.005
POMS Fatigue Score							
	WLC		22	4.59 (3.71)	4.73 (2.80)	1.72	.84
	Total YI		52	4.96 (3.06)	3.79 (2.62)	1.72	.010
	YI subsets	YLC	25	4.60 (3.19)	3.40 (2.36)	1.71	.065
		YHC	27	5.30 (2.96)	4.15 (2.84)	1.71	.067
SF-36 Global Score							
	WLC		19	68.16 (11.25)	67.82 (11.69)	1.61	.87
	Total YI		44	66.21 (11.87)	69.90 (12.73)	1.61	.008
	YI subsets	YLC	19	61.68 (9.67)	64.81 (11.88)	1.60	.13
		YHC	25	69.65 (12.39)	73.73 (12.19)	1.60	.030
SF-36 Role-Physical Score							
	WLC		23	65.22 (37.49)	57.61 (39.48)	1.71	.26
	Total YI		50	54.33 (37.95)	64.17 (35.60)	1.71	.035
	YI subsets	YLC	21	50.00 (38.73)	61.11 (38.04)	1.70	.12
		YHC	29	57.47 (37.75)	66.38 (34.25)	1.70	.14

Table 4. (continued)

Variable	Group	Subset Groups	n	Preintervention M (SD)	Postintervention M (SD)	*df*	*P* Value
SF-36 General Health Score							
	WLC		20	59.99 (19.45)	59.80 (14.05)	1.71	.94
	Total YI		53	61.41 (16.85)	62.57 (17.70)	1.71	.47
	YI subsets	YLC	25	56.94 (17.11)	57.58 (17.17)	1.70	.79
		YHC	28	65.39 (15.86)	67.02 (17.24)	1.70	.47
SF-36 Vitality Score							
	WLC		20	58.25 (17.50)	61.50 (18.36)	1.70	.37
	Total YI		52	59.33 (17.35)	63.65 (17.84)	1.70	.053
	YI subsets	YLC	24	55.21 (14.78)	58.40 (15.51)	1.69	.33
		YHC	28	62.86 (18.89)	68.15 (18.73)	1.69	.083
SF-36 Role-Emotional Score							
	WLC		22	86.36 (26.54)	68.18 (39.14)	1.68	.035
	Total YI		48	61.11 (40.29)	72.92 (35.57)	1.68	.043
	YI subsets	YLC	19	47.37 (38.99)	63.16 (41.41)	1.67	.09
		YHC	29	70.11 (39.18)	79.31 (27.33)	1.67	.22
SF-36 Social Function Score							
	WLC		23	81.52 (21.93)	75.00 (22.61)	1.77	.13
	Total YI		56	77.45 (21.93)	83.70 (21.57)	1.77	.030
	YI subsets	YLC	26	77.40 (19.69)	75.96 (26.20)	1.76	.72
		YHC	30	77.50 (20.86)	90.42 (13.80)	1.76	.001

Abbreviations: QoL = quality of life; DASS-42 = Depression Anxiety Stress Scale; POMS = Profile of Mood States; SF-36 = health survey, short form 36; WLC = waiting-list control; YI = yoga intervention; YLC = yoga low-compliance subset group; YHC = yoga high-compliance subset group; M = mean; SD = standard deviation; *df* = degrees of freedom.

Table 5. Percentage of Participants With Clinically Significant Changes in the Global Scores of the PSQI, POMS, DASS-42, and SF-36 Scales

			Global Scores			
			PSQI	POMS-SF	DASS-42	SF-36
Groups			%	%	%	%
WLC		Deterioration	24	41	5	26
		No Change	52	45	71	53
		Improvement	24	14	24	21
YI		Deterioration	11	41	10	12
		No Change	47	51	63	50
		Improvement	42	8	27	38
YI Subset	YLC	Deterioration	28	43	17	17
Groups		No Change	56	44	65	50
		Improvement	17	13	18	33
	YHC	Deterioration	0	0	3	8
		No Change	41	37	62	50
		Improvement	59	63	35	42

Abbreviations: PSQI = Pittsburgh Sleep Quality Index; POMS = Profile of Mood States; DASS-42 = Depression Anxiety Stress Scale; SF-36 = health survey, short form 36; WLC = waiting-list control; YI = yoga intervention; YLC = yoga low-compliance subset group; YHC = yoga high-compliance subset group.

POMS tension ($P = .044$ vs $P = .85$), POMS anger ($P = .005$ vs $P = .64$), and SF-36 social function ($P = .001$ vs $P = .72$). Significant deterioration was seen in the WLC group only in emotional-role limitation ($P = .035$). Note that for the POMS and DASS-42 scales, an increase in a score compared with the baseline score indicates deterioration. However, for the SF-36 scales, an increase in a score compared with the baseline score indicates an improvement.

In summary, the results show that YI resulted in improvement in many aspects of QoL. Improvement was strongly related to practice compliance level as evidenced by the significant improvement for the YHC group compared with the YLC group. Table 4 summarizes QoL results.

Clinical Significance of the Results

The clinical significance of the results was assessed using the global scores of the PSQI, POMS, DASS-42, and SF-36, as explained in the Methods section. Results show a significantly higher percentage of participants in the YHC group with clinically significant improvements compared with the YLC group and the WLC group. Furthermore, results show a significantly lower percentage of participants in the YHC group with clinically significant deterioration

compared with the YLC group and the WLC group. Results are shown in Table 5. As reported earlier regarding objective measures, statistically significant results were seen only in SWS duration and only in the YHC group. Therefore, clinical significance was assessed only for the global scores of the PSQI, POMS, DASS-42, and SF-36 subjective scales.

DISCUSSION

The present study was a pragmatic one that found benefits for sleep quality and QoL with a simple and economical yoga protocol in a population of older adults presenting with insomnia. The yoga practices, which were graded and adapted for older adults, were supported by 2 weekly, teacher-guided classes and a significant home practice component using an audio CD. Future studies may take this a step further by using DVDs and also providing online yoga classes.

Overall, the findings revealed that practice compliance played an important role and that at least 25 minutes of net daily practice were required to improve most subjective symptoms of insomnia significantly. Approximately 50% of the YI group was able to sustain this level of practice. This finding suggests that it may be possible to improve outcomes further by modifying the practice protocol, providing participants with special DVDs, and/or conducting online yoga classes that would improve compliance and uniformity of home practice. Additional well-powered, randomized, controlled studies are needed to establish the specific practice levels required to achieve changes in sleep and QoL measures.

Diminished subjective sleep quality is one of the most frequent health complaints in older adults[2] and, therefore, the significant improvement seen in most aspects of subjective sleep status in the YI group was an important finding despite the lack of improvement in objective sleep measures. A discrepancy between objective and subjective sleep measures is consistent with previous research.[33] It has been suggested that such discrepancies may be caused by psychological factors[33,34,35] that significantly affect subjective perception of sleep and by the possibility that polysomnography is more sensitive to daily variations as opposed to subjective measures, like the PSQI, that elicit a self-estimate of sleep quality in a 1-month period.[36] In addition to significant improvements in subjective sleep quality found in the present study, as well as in previous studies, the present study has also revealed a significant increase in SWS duration in the YHC group. The SWS is believed to contribute to restorative physiological processes that occur during sleep, and an association has been found between SWS and secretion of growth hormone and increased insulin sensitivity in humans[40-43] and higher rates of brain protein synthesis in rats.[44] The significant increase in SWS duration in the YHC group may suggest that their sleep had become more restorative. The present study supports findings of previous studies that have shown that yogic cyclic meditation was associated with an increased SWS duration and decreased REM sleep duration on the night following practice.[37-39] Yogic cyclic meditation is a yogic practice introduced by Swami Vivekananda based on cycles of static yoga postures followed by supine relaxation periods of several minutes each.

Results revealed a significantly higher percentage of participants in the YHC group compared with the YLC group and controls, with clinically significant improvements in the global scores for subjective scales of sleep quality and QoL. This finding further reinforces the finding that practice compliance played an important role in intervention outcomes.

The present study was subject to various limitations. The study used a wide range of outcome measures but included no single outcome measure or single compound outcome measure. In some cases, using a single compound outcome measure may yield a clear significant answer to the study's main question(s). However, both sleep quality and QoL are complex and multifactorial in nature. Furthermore, the present study made use of subjective questionnaires—PSQI for sleep quality, POMS and DASS-42 for psychological well-being, and SF-36 for general well-being. In addition to a range of subcategory scores, each of these questionnaires has a global or summary score. Looking specifically at the global scores, significant improvements were found in the YI group, but not in the WLC group, for sleep quality, QoL, and daily-function global scores, namely PSQI ($P = .011$ vs $P = .81$), DASS-42 ($P = .010$ vs $P = .21$), POMS ($P = .009$ vs $P = .18$), and SF-36 ($P = .008$ vs $P = .87$). Despite the statistically significant improvements in YI but not in the controls in all summary scores, well-powered, randomized, controlled studies are still needed to draw applicable conclusions regarding the clinical significance of this intervention for a general population of older adults presenting with insomnia complaints.

This trial was a nonrandomized study and as such there is a greater risk of bias than in a randomized trial. In the present study, participants who responded to advertisements about the study were not randomly sampled from a larger population and, thus, a nonresponse bias may exist. Participants were not randomly allocated to the WLC and YI groups, resulting in a greater risk of potential differences between the characteristics of participants in the 2 groups. Different yoga teachers may have also introduced a teaching-quality bias. This bias was reduced by using an identical yoga protocol and an at-home, self-practice audio CD. Future larger-scale, randomized, controlled trials may be well positioned to minimize these biases using randomization of larger populations and random rotation of a larger number of yoga teachers. Larger studies will also be well placed to compare several yoga protocols that emphasize more meditative or postural practices. Future studies may also allow comparison of home practice-based protocols with protocols based on yoga classes only.

CONCLUSIONS

A simple integrated yoga protocol, with a significant at-home component of meditation practice, can improve sleep quality and QoL and is a safe and applicable nondrug intervention for older people with insomnia. Practicing yoga for at least 25 minutes per day for 12 weeks improved subjective

sleep status, the duration of the SWS phase, and psychological and emotional well-being, with improvements being related to practice compliance.

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AUTHOR DISCLOSURE STATEMENT

Dr Clement Cahan and Dr Anda Baharav are affiliated with HypnoCore, Ltd (Petah Tikva, Israel), a medical device company specializing in diagnosis of sleep disturbances. The HC1000P, a HypnoCore product, was used in this study.

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