Dyslipidemia management in overweight or obese adolescents: A mixed-methods clinical trial of motivational interviewing

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Abstract

Background: Lifestyle management for dyslipidemic adolescents often occurs in the context of family-centered care, which necessitates adaptation of counseling strategies.
Objective: To determine the effectiveness of motivational interviewing for lifestyle behavior change for dyslipidemic adolescents in a dyad with a parent versus alone.
Methods: A total number of 32 adolescents were randomized 1:1 to receive a series of motivational interviewing sessions either together with a parent or alone for a 6-month intervention, with both quantitative and qualitative assessment of outcomes.
Results: Both groups were similar at baseline. Following the intervention, there were no significant differences between groups in physical, laboratory, lifestyle or psychosocial measures, except for a reduction in dietary fats/sugars (p = 0.02) and in screen time (p = 0.02) in the alone group. When both groups were combined, significant reductions at 6 months were noted for body mass index (p < 0.001), waist circumference (p < 0.001), total cholesterol (p < 0.001), low-density lipoprotein cholesterol (p < 0.001), triglycerides (p = 0.01), non–high-density lipoprotein cholesterol (p < 0.001), fasting insulin (p = 0.01), and homeostatic model (p = 0.02). Reduced screen time and increased fruit and vegetable intake were also noted for both groups combined. These changes were also reflected in self-efficacy (p = 0.004), self-esteem (p = 0.03), and improvement in quality of life measures. Interview data provided insights into the utility and acceptability of the motivational interviewing intervention.
Conclusion: Motivational interviewing was an efficient strategy for inspiring healthy lifestyle and physiological changes among adolescents in both groups. Family centered pediatric approaches should consider the autonomy and individual preferences of the adolescent prior to counseling.

Keywords

Motivational interviewing, adolescents, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, total cholesterol, triglycerides, overweight, obesity, dyslipidemia, cardiovascular risk

Introduction

Atherosclerotic risk factors accelerate cardiovascular disease,[1,2] a leading cause of morbidity and mortality in adults.[3] Atherosclerosis begins early in childhood[3] and adolescence for those with dyslipidemia, and overweight or obesity.[4–6] Supporting change to achieve healthier lifestyle behaviors is the cornerstone of managed care, but this can be challenging to achieve in a clinical setting. During adolescent development (10–17 years),[7] ambivalence and risk taking are common behaviors as adolescents struggle with moral issues and social interactions while attempting to establish a self-identity.[8–10]

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Motivational interviewing (MI) is emerging as an effective individual counseling strategy that targets ambivalence in an effort to stimulate behavior change.[11–14] However, its feasibility and effectiveness are still underexplored in adolescents, parent and adolescent dyads, and teams or groups.[9,10]

Virtually all pediatric settings adopt a family-centered approach to management, where parents are considered vital and valued partners in care. However, adolescence is a time of emerging independence and self-management, and the role of parents in promoting healthy behavior change may be less clear.[15] Therefore, we sought to test our assumption as to whether a MI-focused intervention would be more effective and accepted when applied to dyslipidemic adolescents in a dyad with a parent versus being counseled alone. While there is some evidence to support the utility of MI in the pediatric population,[16–20] evidence is limited as applied to dyslipidemic adolescents.

Methods

This study was a 6-month randomized clinical trial that used a MI-focused counseling intervention in dyslipidemic adolescents. Participants were randomized 1:1 to receive counseling either together with a parent or alone, with assessment of both quantitative and qualitative outcomes.

Setting and location

The Research Ethics Board at The Hospital for Sick Children approved the study protocol. Newly referred patients were recruited from the outpatient pediatric lipid clinic at The Hospital for Sick Children, a tertiary pediatric hospital in southern Ontario. Parents of eligible patients were mailed an information letter about the study and verbal consent was obtained by a member of the study team by phone from those interested in participation. Written consent and assent was then obtained by the nurse practitioner at the scheduled initial assessment and enrollment clinic visit.

Inclusion/exclusion criteria

Inclusion criteria included patients aged 10–17 years, 12-h fasting lipid profile with triglycerides ≥39 mg/dL (1.0 mmol/L) or high-density lipoprotein cholesterol (HDL-C) ≤46 mg/dL (1.2 mmol/L), with non-HDL-C ≥123 mg/dL (3.2 mmol/L) and waist-to-height ratio ≥0.5. Adolescents on lipid lowering medication and those who were non-English speaking or who had mental health issues or developmental delay were excluded.

Sample size

Change in total cholesterol to HDL-C ratio was chosen as the primary outcome for sample size estimation. This ratio has been shown to be a good overall surrogate marker of cardiometabolic risk.[21,22] We hypothesized a greater change in this ratio in the adolescent/parent dyad group versus the adolescent alone group (−0.6 ± 0.5 vs −0.1 ± 0.5, respectively), with a clinically meaningful difference representing 1 standard deviation of the change. With a two-tailed alpha of 0.05 and a power of 0.80, an estimated sample size of 16 participants in each group would be required. For the qualitative component, a minimum of eight interviews were considered sufficient when examining a selected phenomenon;[23] however, an invitation to participate in the study endpoint interview was extended to all participants in either group.

Study intervention

A randomization scheme using random blocks and a random number generator was developed, and tamperproof, consecutively numbered allocation envelopes were provided by personnel not directly involved in the study. Participants were assigned the next envelope in sequence after consent was obtained. Following the baseline assessment and requisite testing, patients and their parents attended a group education class about the nature and risks of dyslipidemia, healthy eating, and physical activity behaviors. Adolescents in both groups (with parents per allocation) then took part in a brief individual discussion regarding their assessment findings and lipid profile results. A preliminary management plan was provided by the same nurse practitioner who then remained their MI counselor for the duration of the study. Participants were also provided with their visit schedule and the counselor's contact information.

After the baseline visit, all participants received four MI sessions and four follow-up phone calls over a 6-month period. Each individualized MI session was approximately 30–45 min in duration. The number and frequency of MI sessions were based on previous reports.[24,25] All MI sessions occurred in an examination room in the lipid clinic.

For the adolescent/parent dyad group, the same parent attended every session and collaboratively participated in agenda setting and the action plan for the subsequent month. The focus of the sessions was the adolescent regardless of group allocation. Notwithstanding, parents in the dyad group were considered as involved partners and encouraged to actively participate equally in the discussions, providing input, support, and reinforcement regarding the planned actions or changes. Adolescents in the alone group were unaccompanied during their sessions, although discussions included strategies to enlist and leverage family support.

The agenda for each MI session was structured in collaboration with the adolescents and their stage of readiness for change. The purpose of the first MI session was to assess the adolescents' sense of ambivalence, knowledge, and understanding; personal strengths; barriers and facilitators affecting their lifestyle; and the pros and cons of making a change. In addition, their readiness to acknowledge their problem behavior was explored and information was provided,

outcomes were set, and a plan for selected aspect(s) of change were facilitated by the MI counselor with feasible targets. Adjunctive materials were also offered to participants in both groups, such as pedometers, elastic exercise bands, useful websites, and cook books. To address participants' ambivalence about changing behavior, the counselor used MI techniques, incorporating key MI principles, including empathy, autonomy, and agenda setting. The MI counselor used decisional balances, tools to measure readiness for change,[25] and asked relevant, open-ended questions. Together, with guidance from the MI counselor, participants explored personal and intrinsic motivation to support making a desired behavioral change by identifying their strengths and self-efficacy. The counselor was sensitive in respecting the participants' autonomy and assessing their body language, in clarifying or reframing verbal input, and in employing MI skills to address resistance to change when apparent.

The MI counselor received training from the MI Network of Trainers in two, 3-day advanced MI training workshops and participated in regular practice sessions. These MI sessions were audited and ongoing feedback was provided by both the MI Network of Trainers and a clinical psychologist (an MI-trained expert from a regional mental health facility) for nine randomly selected MI sessions. Sessions were evaluated using a behavior coding system that measured the fidelity or trustworthiness of the MI intervention (Motivational Interviewing Treatment Integrity).[26] High scores for fidelity were consistent throughout the training and audits.

Two weeks after each MI session, participants in both groups received a brief phone call (approximately 5–10 min) from their MI counselor to answer questions and to reinforce progress. Those in the adolescent/parent dyad group were encouraged to use phone extensions, if possible, to facilitate shared communication with both the parent and the adolescent. The MI counselor spoke with the adolescent only in the alone group.

Study measures

Before their initial assessment (baseline visit) and again prior to the study endpoint (6-month follow-up visit), all participants were mailed a homework package to complete a 4-day food record and a set of health-related questionnaires. At the baseline and endpoint visits, all patients had fasting blood work, physical measures, and other assessments as described in the next section. Study personnel conducting technical assessments and testing were blind as to the group allocation. Qualitative semi-structured interviews were conducted at the study endpoint with all participants from both groups.

Physical measures

The methods for standardized anthropometry assessment from the 2007–2010 National Health and Nutrition Examination Survey's (NHANES) were used.[27] Measurements were performed and recorded by the same study personnel for the assessment of height, weight, waist circumference (three readings, averaged), and waist-to-height ratio. Body mass index (BMI) was calculated, and measurements were plotted using the Centers for Disease Control normal charts. Blood pressure was measured (three readings, averaged) for systolic and diastolic blood pressure using an automatic oscillometric blood pressure monitor with an appropriately sized cuff on the right arm after resting for 5 min in a sitting position. Each participant also underwent an air-displacement plethysmography (BOD POD®) assessment to measure body composition (fat and fat-free mass).[19,28] Carotid-femoral pulse wave velocity, an indicator of arterial stiffness, was measured using a SphygmoCor SCOR-PVx System (AtCor Medical) and calculated in meters per second.[29,30]

Laboratory measures

The primary outcome was change in fasting lipid values. Early morning, 12-h fasting blood samples were tested for total cholesterol, HDL-C, and triglycerides. The levels of low-density lipoprotein cholesterol (LDL-C), non-HDL-C, total cholesterol to HDL-C ratio, and triglyceride to HDL-C ratio were calculated. Additional assessments included apolipoprotein B, glucose, insulin, high-sensitivity C-reactive protein (hs-CRP), liver function (aspartate aminotransferase and alanine aminotransferase), and thyroid function (thyroxine and thyroid-stimulating hormone). From fasting glucose and insulin values, homeostatic model assessments (HOMA-IR) were calculated.

Lifestyle measures

The BLOCK Kids Questionnaire, a self-report, validated instrument to estimate a 7-day intake of nutrients and food groups, was completed.[31,32] A Healthy Eating Assessment Tool (HEAT) was used to calculate dietary quality and eating behaviors (per Canada's food guide), and a "heat" score was given based on the questionnaire and interview assessment by the clinic's dietician.[33] Objectively measured physical activity levels were assessed by omnidirectional accelerometry, a tracking device worn at the waist for seven consecutive days.[34,35] The Heart Niagara Questionnaire was used to assess self-reported lifestyle behaviors and family history.[36]

Psychometric measures

Four questionnaires with acceptable psychometric properties were completed by all participants and assessed various aspects of psychosocial well-being and quality of life. These included (1) the Rosenberg Self-Esteem Scale,[37] assessing self-worth and confidence; (2) the Children's Self-Efficacy Scale,[38–40] testing the belief in oneself in various situations; (3) the Pediatric Quality of Life Inventory (Peds-QL),[41] for social, emotional, physical, and academic functioning; and

Table 1. Question template for participant interviews at the 6-month study endpoint.

	Interview Script Template
1.	Tell me how you felt when you were first told about your cholesterol. Who told you? Who did you tell about this? What did you talk about?
2.	Your family doctor then referred you to The Hospital for Sick Children (Sick Kids). How did that make you feel, coming to a special clinic?
3.	Describe what you remember about your first visit at Sick Kids. Can you tell me what you remember from the education session that day?
4.	You then took part in this study where you had special counseling (with both of you alone). In what ways were these sessions (with the nurse practitioner) different from the first large, education session?
5.	The special counseling sessions are known to help motivate kids to make positive changes/decisions and achieve to their goals. What about you? What do you think?
6.	Think about a kid who's in a similar situation as you (someone who has high cholesterol and is trying to achieve a healthy weight) … What are some of the things that you would tell this person?
7.	Would you recommend this study's methods (the "sessions" with your counselor) to others in situations like yours? What would you tell them?
8.	You made changes, right? Did you make your own decisions? Who specifically was involved in helping you? How? What helped you stay on track? Did anything else help?
9.	What other things come to mind when you think about being part of this research study? In the future, would you choose to be in a study? Why/why not?

(4) an adapted version (with permission from the original authors) of the MI Readiness to Change questionnaire to ascertain their current MI stage.[42]

Study endpoint interviews

To ascertain the experiences and perspectives of adolescents about their health issues and the intervention, individual, 45-min interviews (with the adolescent/parent dyad or the adolescent alone as per the study allocation) were conducted at the endpoint visit at 6 months. Two trained qualitative interviewers not involved in the study assessment or intervention conducted the interviews using a script of semi-structured questions (Table 1). All interviews were audiotaped and the interviewers took field notes to summarize the discussion at the end of each interview to validate key points made by adolescents and/or parents and to allow for any other additional comments.

Data analysis

Data are described as frequencies, mean with standard deviations, and median values with interquartile ranges as appropriate. Comparisons of baseline characteristics between the adolescent/parent dyad group and the adolescent alone group were performed using Fisher's exact test for all categorical variables, and Student's t-test assuming unequal variance between samples for continuous variables (Satterthwaite methods). Changes in study measures within and between groups were assessed using repeated measures methodology, including linear regression models with an autoregressive covariance structure for continuous variables, logistic regression models with an autoregressive covariance structure for binary outcomes, and multinomial regression with independent covariance structure for ordinal variables. The interaction term between study group and assessment time (baseline or endpoint/post-intervention) was used to determine the statistical significance of the change from baseline versus 6-month visit within and between groups, and with both groups combined. All statistical analyses were performed using SAS v9.4 (SAS Statistical Software, Cary, NC).

Qualitative data from the interviews were assessed by two researchers from the study team using directed content analysis procedures[43] to collaboratively arrive at themes from this qualitative descriptive method of inquiry.[44] The directed approach was chosen as a means to explore the elements of a conceptual framework for MI, developed prior to this planned clinical trial.[45]

Results

Participants

Of the 115 patients screened during the recruitment period (November 2012 to February 2014), 34 were eligible and consented to participate (46 declined and 35 did not fully meet the study criteria). Reasons for declining included family time constraints, travel distance, or a lack of interest. One participant in the adolescent alone group, directly after consent, revealed a recent diagnosis of depression and was immediately withdrawn. Another in the adolescent/parent dyad group experienced an anxiety episode during early baseline testing and withdrew from further participation. Adolescents were randomized to either the adolescent/parent dyad group (n = 17) or the adolescent alone group (n = 17). Therefore, 32 participants comprised the full sample (n = 16/group). During the study, no participant from either group missed their scheduled MI session or phone call discussion. The study sample is shown in Figure 1, adapted from the Consolidated Standard of Reporting Trials (CONSORT) statement (Online Appendix).[45]

Baseline characteristics

Tables 2–6 show baseline and 6-month study measures. Each group consisted of 10 males (62%) and 6 (38%) females, and
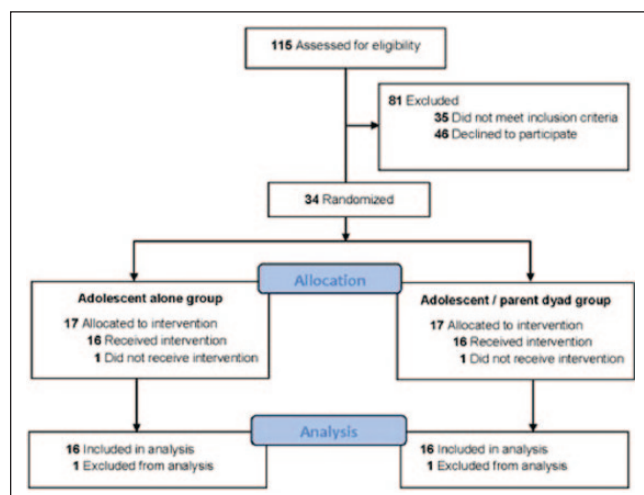
Figure I. Study trial CONSORT-flow diagram.

mean age among child participants did not differ (mean: 12.8±2.2 years for the adolescent/parent dyad group vs 13.7±2.5 years in the adolescent alone group; p=0.62). No significant differences were found for either group regarding physical (Table 2), laboratory (Table 3), lifestyle (Table 4), or psychosocial measures (Table 5) at baseline.

Changes in physical measures

There were no significant differences found between groups for changes in physical measures (Table 2). However, when both groups were combined, significant increases were seen in height, with significant decreases in weight, BMI, waist circumference, waist-to-height ratio, percentage of fat mass, percentage of fat-free mass, and systolic blood pressure z-score. There were no significant changes in pulse wave velocity.

Changes in laboratory measures

There were no significant differences between groups for changes in laboratory measures (Table 3). In particular, the standard deviation of change in total cholesterol-to-HDL-C ratio was significantly greater than hypothesized, with a mean change of −0.62±0.96 in the adolescent/parent dyad group versus −0.15±0.96 in the adolescent alone group. Given these findings and the achieved sample size, the power to detect this observed difference was 0.29. When combining both groups, significant decreases were observed in total cholesterol, LDL-C, non-HDL-C, and triglycerides, but no significant change was seen in HDL-C, triglyceride-to-HDL-C ratio or apolipoprotein B (Figure 2). In addition, both groups combined showed significant decreases in fasting insulin levels, HOMA-IR, and ALT from study baseline to endpoint, but no change in fasting glucose, AST, or hs-CRP.

Changes in lifestyle measures

From the BLOCK Questionnaire, participants in the adolescent alone group had significantly greater reduction in servings per day of fats and oils/sweets/soda than the adolescent/parent dyad group (p=0.05 as continuous variable and p=0.02 as an ordinal variable, respectively), which was also significant when both groups were combined (Table 4). Both groups combined showed significant increases in servings per day of vegetables. Changes in HEAT scores were not found to be significant between groups but when both groups were combined, an improvement in scores was seen. There was no significant difference between groups for changes in self-reported time spent being physically active, but a significant improvement was noted when combining both groups. Reduction in self-reported screen time was significantly greater in the adolescent alone group and was also significant for both groups combined. Changes in objectively measured physical activity levels from accelerometry data were not found to be significant between groups or when both groups were combined. No significant differences in self-reported sleep time were noted.

Self-reported outcomes in lifestyle behaviors from the Heart Niagara Questionnaire (Table 5) did not show significant changes between groups, yet when both groups were combined, improvements were seen in dietary restraint, with reductions in screen time.

Changes in psychosocial measures

There were no significant differences between groups in changes for scores on the PedsQL questionnaire, but both groups combined showed significant improvements in physical, emotional, and social functioning, but not school functioning (Table 6). Likewise, there were no significant differences in changes between groups regarding scores in self-efficacy, although the combined groups showed significant improvements in total and emotional, but not social self-efficacy. Similar positive findings were noted for improvements in self-esteem.

With both groups combined, there were significant advances through stages of change related to physical activity, healthy eating, and screen time using the adapted version of the MI Readiness to Change questionnaire[42] (Table 7).

Qualitative interviews

Data from the 32 study endpoint interviews were organized under the four elements of the MI conceptual framework: the person, the problem, the process, and the provider/counselor.[45] In accordance with the interview guide (Table 1), the data predominantly reflected the perspectives of adolescents; however, relevant input from parents in the adolescent/parent dyad group was also included.

Table 2. Changes in physical measures.

	N	Adolescent/parent dyad (baseline)	N	Adolescent alone (baseline)	p	N	Adolescent/parent dyad (6 months)	N	Adolescent alone (6 months)	p	p*	p**
Demographic data												
Gender (male)	16	10 (63%)	16	10 (63%)	1.00							
Age (mean±SD)	16	12.8±2.2	16	13.7±2.5	0.62	16	13.2±2.2	16	14.2±2.5	0.59	0.14	0.03
Weight (kg)	16	75.6±20.6	16	81.9±21.3	0.41	16	75.0±21.9	16	79.0±18.6	0.97	0.28	<0.001
Height (cm)	16	160±12	16	160±10	0.87	16	163±12	16	163±10	0.35	0.32	<0.001
BMI (kg/m^2)	16	29.2±4.7	16	31.5±6.4	0.24	16	27.8±4.9	16	29.6±5.7	0.66	0.12	<0.001
Waist (cm)	16	98.3±11.9	16	102.8±13.8	0.32	16	93.1±12.8	16	95.1±13.0	0.58	0.19	<0.001
Waist-to-height ratio	16	0.62±0.05	16	0.64±0.08	0.28	16	0.57±0.06	16	0.59±0.08	0.35	0.37	0.08
Blood pressure systolic (mmHg)	16	124±14	16	125±20	0.76	16	121±11	16	117±11	0.24	0.38	0.04
Blood pressure systolic z-score	16	1.32±1.28	16	1.44±1.90	0.84	16	0.94±0.96	16	0.53±0.93	0.88	0.79	0.4
Blood pressure diastolic (mmHg)	16	65±8	16	67±5	0.49	16	64±11	16	65±12	0.95	0.79	0.28
Blood pressure diastolic z-score	16	0.10±0.79	16	0.23±0.50	0.61	16	−0.05±1.10	16	−0.03±1.15			
Body composition												
Percentage of fat mass	16	39±9	16	39±8	0.98	16	39±8	16	37±9	0.97	0.98	0.03
Percentage of fat-free mass	16	61±9	16	61±8	0.98	16	61±8	16	63±9	0.97	0.98	0.03
Body fat rating for male	10		10			10		10				
Risky body fat (>30.0%)		8 (80%)		8 (80%)			6 (60%)		6 (60%)			
Excess fat (20.1%–30.0%)		1 (10%)		2 (20%)			3 (30%)		4 (40%)			
Moderately lean (12.1%–20.0%)		1 (10%)		0 (0%)			1 (10%)		0 (0%)			
Body fat rating for female	6		6			6		6				
Risky body fat (>40%)		4 (67%)		3 (50%)			2 (33%)		2 (33%)			
Excess fat (30.1%–40.0%)		2 (33%)		2 (33%)			4 (67%)		3 (50%)			
Moderately lean (22.1%–30.0%)		0 (0%)		1 (17%)			0 (0%)		1 (17%)			
Vascular												
PWVcr (m/s)	16	6.9±1.2	16	6.6±0.8	0.89	16	6.9±0.8	16	6.8±0.9	0.45	0.52	0.12
PWVcf (m/s)	16	5.5±0.9	16	5.3±0.7	0.72	16	5.4±0.7	16	5.4±0.6	0.86	0.52	0.22

SD: standard deviation; BMI: body mass index; PWVcr: carotid-radial pulse wave velocity; PWVcf: carotid-femoral pulse wave velocity.
*p value of the interaction of group (adolescent/parent dyad vs adolescent alone) by time (baseline vs 6 months).
**p value of the change from baseline to 6 months (all patients combined).

Table 3. Changes in laboratory measures.

	N	Adolescent/parent dyad (baseline)	N	Adolescent alone (baseline)	p	N	Adolescent/parent dyad (6 months)	N	Adolescent alone (6 months)	p	p*	p**
Lipid profile												
TC (mmol/L)	16	5.4±0.5	16	5.3±0.6	0.59	16	4.7±0.9	16	4.7±0.8	0.96	0.58	<0.001
LDL-C (mmol/L)	16	3.3±0.4	14	3.2±0.5	0.33	15	2.9±0.7	14	2.8±0.6	0.58	0.66	<0.001
HDL-C (mmol/L)	16	1.1±0.2	16	1.2±0.3	0.19	16	1.1±0.2	16	1.1±0.3	0.43	0.44	0.25
TG (mmol/L)	16	1.9±0.8	16	2.5±1.2	0.12	16	1.7±1.0	16	1.8±1.2	0.81	0.16	0.01
Non-HDL-C (mmol/L)	16	4.3±0.6	16	4.1±0.5	0.23	16	3.6±0.9	16	3.6±0.8	0.81	0.43	<0.001
TG/HDL-C ratio	16	2.0±1.2	16	2.3±1.5	0.52	16	1.8±1.5	16	1.8±1.5	0.98	0.45	0.13
TC/HDL-C ratio	16	5.3±1.3	16	4.6±0.8	0.09	16	4.6±1.3	16	4.4±1.4	0.65	0.16	0.03
HDL-C/TC ratio	16	0.20±0.05	16	0.23±0.05	0.13	16	0.23±0.06	16	0.25±0.04	0.49	0.52	0.003
Apo B	16	0.99±0.14	16	0.92±0.20	0.26	16	0.93±0.20	16	0.91±0.21	0.77	0.37	0.19
Glycemic profile												
Fasting glucose (mmol/L)	16	5.0±0.4	16	5.1±0.4	0.49	16	5.1±0.3	16	5.1±0.4	1.00	0.43	0.89
Fasting insulin (pmol/L)	16	130±67	16	113±76	0.50	16	104±66	16	92±42	0.54	0.77	0.01
HOMA-IR	16	4.2±2.1	16	3.8±2.6	0.61	16	3.4±2.2	16	3.1±1.6	0.64	0.87	0.02
Other serology												
AST (U/L)	16	28.3±8.9	16	27.8±8.5	0.86	16	25.2±5.1	16	25.8±7.5	0.81	0.71	0.11
AST<40U/L	16	14 (88%)	16	14 (88%)	1.00	16	16 (100%)	16	14 (88%)	0.49		0.32
ALT (U/L)	16	40.1±18.8	16	37.6±15.7	0.69	16	32.2±9.2	16	31.7±12.3	0.90	0.74	0.03
ALT<40U/L	16	10 (63%)	16	10 (63%)	1.00	16	13 (81%)	16	12 (75%)	1.00	0.71	0.13
hs-CRP (mg/L)	16	1.3 (0.8–2.7)	16	1.4 (1.0–5.1)	0.21	16	1.0 (0.6–2.4)	16	1.8 (0.8–3.3)	0.89	0.16	0.95
hs-CRP<0.7 mg/L	16	3 (19%)	16	3 (19%)	1.00	16	5 (31%)	16	2 (13%)	0.39	0.23	0.71

TC: total cholesterol; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; TG: triglycerides; TG/HDL-C ratio: calculated triglyceride-to-high-density lipoprotein cholesterol ratio; TC/HDL-C ratio: calculated total cholesterol-to-high-density lipoprotein cholesterol ratio; HDL-C/TC ratio: calculated high-density lipoprotein cholesterol-to-total cholesterol ratio; HOMA-IR: homeostatic model assessment for insulin resistance; AST: aspartate aminotransferase; ALT: alanine aminotransferase; Apo B: apolipoprotein B; hs-CRP: high-sensitivity C-reactive protein.
*p value of the interaction of groups (adolescent/parent dyad vs adolescent alone) by time (baseline vs 6 months).
**p value of the change baseline to 6 months (all patients combined).

Table 4. Changes in lifestyle measures.

	N	Adolescent parent dyad (baseline)	N	Adolescent alone (baseline)	p	N	Adolescent/parent dyad (6 months)	N	Adolescent alone (6 months)	p	p*	p**
BLOCK Questionnaire												
Vegetables (servings/day)	16	1 (0–1)	16	1 (0–2)	0.93	16	2 (1–3)	14	2 (1–4)	0.80	0.95	0.003
None		4 (25%)		6 (38%)	0.89		2 (13%)		2 (14%)	1.00	0.92	0.01
1–2		9 (56%)		7 (44%)			6 (38%)		6 (43%)			
3–7		3 (19%)		3 (19%)			8 (50%)		6 (43%)			
Fruits and fruit juices (servings/day)	16	1 (1–2)	16	1 (1–2)	0.80	16	2 (1–2)	14	2 (1–2)	0.47	0.60	0.15
None		2 (13%)		3 (19%)	1.00		3 (19%)		1 (7%)	0.75	0.43	0.78
1–2		11 (69%)		10 (63%)			10 (63%)		10 (71%)			
3–4		3 (19%)		3 (19%)			3 (19%)		3 (21%)			
Breads/cereals/rice/pasta (servings/day)	16	3 (2–4)	16	3 (2–5)	0.77	16	3 (2–4)	14	3 (2–3)	0.49	0.36	0.24
0–1		2 (13%)		1 (6%)	1.00		3 (19%)		3 (21%)	1.00	0.49	0.08
2–5		12 (75%)		12 (75%)			12 (75%)		10 (71%)			
6–8		2 (13%)		3 (19%)			1 (6%)		1 (7%)			
Meat/fish/poultry/beans/egg (servings/day)	16	1 (1–2)	16	1 (1–1)	0.07	16	1 (1–2)	14	1 (0–1)	0.24	0.65	0.55
None		0 (0%)		2 (13%)	0.27		2 (13%)		6 (43%)	0.07	0.19	0.43
1		10 (63%)		11 (69%)			6 (38%)		6 (43%)			
2–4		6 (38%)		3 (19%)			8 (50%)		2 (14%)			
Milk/yogurt/cheese (servings/day)	16	1 (1–2)	16	1 (1–1)	0.25	16	2 (1–2)	14	1 (1–2)	0.60	0.68	0.40
None		1 (6%)		4 (25%)	0.31		3 (19%)		1 (7%)	0.41	0.37	0.24
1		9 (56%)		9 (56%)			5 (31%)		8 (57%)			
2–3		6 (38%)		3 (19%)			8 (50%)		5 (36%)			
Fats and oils/sweets/sodas (servings/day)	16	2 (1–3)	16	2 (1–3)	0.47	16	2 (1–2)	14	1 (0–2)	0.03	0.05	0.001
None		1 (6%)		0 (0%)	1.00		1 (6%)		4 (29%)	0.14	0.02	0.001
1–2		9 (56%)		9 (56%)			13 (81%)		10 (71%)			
3–6		6 (38%)		7 (44%)			2 (13%)		0 (0%)			
HEAT score												
Total score (#/10)	16	3.0 (2.3–4.0)	16	4.0 (2.5–5.0)	0.41	16	7.5 (6.0–8.5)	16	7.5 (6.0–8.3)	0.92	0.51	<0.001
Poor (0–2.5)		9 (56%)		6 (38%)	0.48		1 (6%)		0 (0%)	0.72	0.39	<0.001
Fair to good (3.0–5.0)		7 (44%)		10 (63%)			5 (31%)		7 (44%)			
Very good to excellent (≥5.5)		0 (0%)		0 (0%)			10 (63%)		9 (56%)			
Physical activity												
Physical activity time (h/week)	16	0 (0–1)	16	0 (0–1)	0.74	16	12 (8–15)	16	10 (7–14)	0.60	0.57	<0.001
Accelerometry												
MVPA (min/day)	11	11 (7–14)	13	11 (8–15)	0.74	13	10 (5–20)	12	9 (7–11)	0.73	0.77	0.56
Steps (×1000/day)	11	2.05±0.63	13	2.16±0.77	0.69	13	1.78±1.17	12	2.15±1.16	0.44	0.45	0.26
Screen time												
Cumulative screen time (h/week)	16	26 (22–33)	16	34 (23–46)	0.14	16	17 (11–23)	16	14 (10–15)	0.13	0.02	<0.001
Sleep												
Sleep time (h/day)	16	9 (8–9)	16	9 (8–9)	0.31	16	9 (8–10)	16	9 (8–10)	0.45	0.32	0.42

MVPA: moderate to vigorous physical activity.
*p value of the interaction of group (adolescent/parent dyad vs adolescent alone) by time (baseline vs 6 months).
**p value of the change from baseline to 6 months (all patients combined).

Table 5. Changes in lifestyle measures (The Heart Niagara Questionnaire).

	N	Adolescent / parent dyad (baseline)	N	Adolescent Alone (baseline)	p	N	Adolescent / parent dyad (6 months)	N	Adolescent Alone (6 months)	p	p*	p**
Heart Niagara Questionnaire												
How would you rate your overall health?	16		16		1.00	16		15		0.84	0.70	0.71
Poor		2 (13%)		3 (19%)			2 (13%)		2 (13%)			
Fair to good		12 (75%)		11 (69%)			11 (69%)		12 (80%)			
Very good to excellent		2 (13%)		2 (13%)			3 (19%)		1 (7%)			
How would you rate your stress level?	14		16		0.59	15		15		1.00	0.08	0.19
Poor		1 (7%)		3 (19%)			1 (6%)		1 (7%)			
Fair to good		8 (57%)		10 (63%)			10 (63%)		9 (60%)			
Very good to excellent		5 (36%)		3 (19%)			5 (31%)		5 (33%)			
Do you buy lunch at school?	16		16		0.82	16		15		1.00	0.66	0.34
Almost always or always		1 (6%)		0 (0%)			0 (0%)		0 (0%)			
Sometimes		5 (31%)		6 (38%)			4 (25%)		5 (33%)			
Almost never or never		5 (31%)		8 (50%)			6 (38%)		9 (60%)			
Not applicable		5 (31%)		2 (13%)			6 (38%)		1 (7%)			
How often do you eat dinner with at least 1 person?	16		16		0.14	16		15		0.39	0.64	0.15
0–3 times		3 (19%)		8 (50%)			2 (13%)		4 (27%)			
4–7 times		13 (81%)		8 (50%)			14 (88%)		11 (73%)			
When I feel sad, I often overeat	16		16		1.00	16		15		0.65	0.31	0.84
Definitely/mostly true		3 (19%)		4 (25%)			4 (25%)		2 (13%)			
Definitely/mostly false		13 (81%)		12 (75%)			12 (75%)		13 (87%)			
When I feel lonely, I console myself by eating	15		16		0.69	16		15		1.00	0.84	0.50
Definitely/mostly true		4 (27%)		3 (19%)			3 (19%)		2 (13%)			
Definitely/mostly false		11 (73%)		13 (81%)			13 (81%)		13 (87%)			
Scale of 1 (no restrain) to 8 (total restrain)	14	4±2	16	4±2	0.42	14	6±2	14	5±2	0.66	0.85	<0.001
1–2		2 (14%)		4 (29%)	0.76		1 (6%)		1 (7%)	0.66	0.98	0.003
3–5		9 (64%)		8 (57%)			5 (31%)		5 (36%)			
6–8		3 (21%)		2 (14%)			10 (62%)		7 (50%)			
Minutes spent exercising or playing sports in class	15		16		1.00	15		15		0.47	0.38	0.38
<30		7 (47%)		7 (47%)			5 (31%)		7 (47%)			
>30		8 (53%)		8 (53%)			11 (69%)		8 (53%)			
Hours/day usually watch TV/video movies	15		16		0.32	16		15		0.52	0.36	0.02
≤1		7 (47%)		5 (33%)			9 (56%)		10 (67%)			
2		2 (13%)		6 (40%)			3 (19%)		4 (27%)			
≥3		6 (40%)		4 (27%)			4 (25%)		1 (7%)			
Hours/day usually spent on the computer	16		16		0.06	16		14		0.37	0.87	0.004
≤1		10 (67%)		4 (25%)			14 (88%)		9 (64%)			
2		2 (13%)		7 (44%)			1 (6%)		2 (14%)			
≥3		3 (20%)		5 (31%)			1 (6%)		3 (21%)			
Hours/day usually spent playing video games	15		16		0.48	14		14		1.00	0.98	0.62
0		4 (27%)		6 (38%)			5 (31%)		4 (29%)			
≤2		8 (53%)		5 (31%)			8 (50%)		8 (57%)			
≥3		3 (20%)		5 (31%)			3 (19%)		2 (14%)			
Minutes/day spent on mobile devices	15		16		1.00	16		14		0.88	0.82	0.07
0–10		4 (27%)		6 (38%)			10 (63%)		7 (50%)			
11–30		8 (53%)		4 (25%)			2 (13%)		3 (21%)			
≥31		5 (33%)		6 (38%)			4 (25%)		4 (29%)			
Importance of connection between PA and health	15	15 (100%)	15	15 (100%)	1.00	16	16 (100%)	14	14 (100%)	1.00		

*p value of the interaction of groups (adolescent/parent dyad vs adolescent alone) by time (baseline vs 6 months).
**p value of the change from baseline to 6 months (all patients combined).

Table 6. Changes in psychosocial measures.

	N	Adolescent / parent dyad (baseline)	N	Adolescent alone (baseline)	p	N	Adolescent / parent dyad (6 months)	N	Adolescent alone (6 months)	p	p*	p**
Pediatric Quality of Life Questionnaire												
Physical functioning	14	66 ± 26	14	69 ± 23	0.69	16	76 ± 24	15	81 ± 22	0.61	0.93	0.03
Emotional functioning	14	74 ± 26	14	67 ± 25	0.44	16	78 ± 27	15	72 ± 22	0.56	0.79	0.03
Social functioning	14	73 ± 22	14	71 ± 19	0.75	16	83 ± 24	15	83 ± 20	0.97	0.94	0.01
School functioning	14	69 ± 24	14	62 ± 22	0.48	16	68 ± 25	15	74 ± 18	0.46	0.30	0.29
Self-Efficacy Questionnaire for Children												
Total self-efficacy	16	28 ± 7	16	29 ± 6	0.59	16	31 ± 6	15	31 ± 6	0.82	0.61	0.004
Social self-efficacy	16	30 ± 6	16	29 ± 6	0.78	16	32 ± 6	15	30 ± 5	0.44	0.64	0.10
Emotional self-efficacy	16	26 ± 6	16	26 ± 6	0.85	16	29 ± 5	15	27 ± 7	0.45	0.32	0.02
Rosenberg Self-Esteem Scale												
Sum of all scores	16	20 (18–23)	16	21 (16–24)	0.93	16	25 (20–26)	15	22 (18–27)	0.49	0.25	0.03

A higher reported score means a higher level of functioning as defined in Pediatric Quality of Life Questionnaire, Self-Efficacy Questionnaire for Children, and Rosenberg Self-Esteem Scale.
*p value of the interaction of groups (adolescent/parent dyad vs adolescent alone) by time (baseline vs 6 months).
**p value of the change from baseline to 6 months (all patients combined).
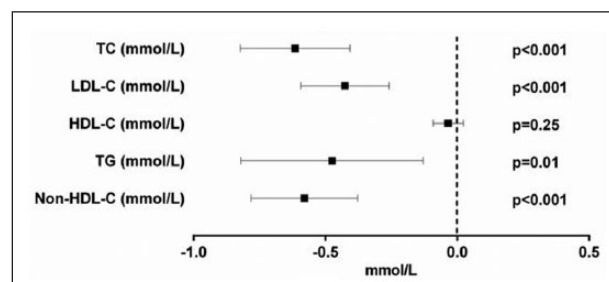
Figure 2. Changes in lipid profile between baseline and follow-up for both groups combined (adolescent/parent dyad and adolescent alone groups).
TC: total cholesterol; LDL-C: low-density lipoprotein cholesterol; HDL-C: high-density lipoprotein cholesterol; TG: triglycerides; non-HDL-C: non–high-density lipoprotein cholesterol.

The person. Overweight and obesity were considered an issue by virtually all adolescent participants. Most said they "*didn't feel good*" about their body or had low self-esteem and many experienced teasing and bullying, which had a negative impact on their school performance. Adolescents also acknowledged making unhealthy food choices and eating "*junk food*." When adolescents learned that they had high "*cholesterol*" (their term for dyslipidemia) and needed to be referred to a specialist, they voiced being frightened by its potential health impact and were disappointed that "*it*" (their cholesterol findings) was not fully discussed by their referring family physician or by their parents: "*I didn't know, like, how serious it was*"; "*I thought it was just a blood test.*" Most adolescents were aware that their lifestyle behaviors had an influence on their cholesterol levels, but they were challenged by this, since they did not "*feel*" or "*look*" sick. The adolescents objectified their blood results as "*the cholesterol*" or getting "*it*" down. Those in the adolescent alone group tended to feel a greater sense of personal responsibility and accountability in the process (the MI sessions and "*my plan*") and felt they would not do as well if their parent was in attendance: "*My Mom would have talked for me and I didn't want that.*" They felt it was "*my problem*," "*my life*," "*my healthy choice.*" For the adolescent/parent dyad group, the adolescents were not as autonomous and accountable for their decision making and action processes. They reported more dependency on their parent: "*My mother reminds me*," and one parent reported "*I had to take control of managing screen time.*"

The problem. Ambivalence to behavior change (the problem) was related to eating for emotional reasons, being "*stubborn*," "*lazy*," or to fit in with peers. Adolescents also expressed a lack of knowledge partly because support at home was not apparent or consistent. Change was either not thought of or seemed overwhelming without support.

The process. Adolescents in both groups agreed that the frequency of the MI sessions was adequate for achieving a sense

Table 7. Characteristics of adolescents "readiness" to change.

	Adolescent/parent dyad		Adolescent alone		Combined	
	Baseline	6 months	Baseline	6 months	Baseline	6 months
Physical activity stages						
1. Pre-contemplation	0 (0%)	0 (0%)	1 (6%)	0 (0%)	1 (3%)	0 (0%)
2. Contemplation	6 (38%)	1 (6%)	9 (56%)	1 (7%)	15 (47%)	2 (6%)
3. Preparation	1 (6%)	0 (0%)	1 (6%)	3 (20%)	2 (6%)	3 (10%)
4. Decision/action	3 (19%)	5 (31%)	0 (0%)	0 (0%)	3 (9%)	5 (16%)
5. Maintenance	6 (38%)	10 (63%)	5 (31%)	11 (73%)	11 (34%)	21 (68%)
Healthy eating stages						
1. Pre-contemplation	0 (0%)	1 (6%)	3 (19%)	2 (14%)	3 (9%)	3 (10%)
2. Contemplation	9 (56%)	2 (13%)	8 (50%)	0 (0%)	17 (53%)	2 (7%)
3. Preparation	5 (31%)	8 (50%)	3 (19%)	6 (43%)	8 (25%)	14 (47%)
4. Decision/action	0 (0%)	0 (0%)	0 (0%)	1 (7%)	0 (0%)	1 (3%)
5. Maintenance	2 (13%)	5 (31%)	2 (13%)	5 (36%)	4 (13%)	10 (33%)
Screen time stages						
1. Pre-contemplation	2 (13%)	0 (0%)	4 (27%)	3 (20%)	6 (19%)	3 (10%)
2. Contemplation	10 (63%)	2 (13%)	4 (27%)	3 (20%)	14 (45%)	5 (16%)
3. Preparation	2 (13%)	4 (25%)	6 (40%)	1 (7%)	8 (26%)	5 (16%)
4. Decision/action	1 (6%)	4 (25%)	1 (7%)	3 (20%)	2 (6%)	7 (23%)
5. Maintenance	1 (6%)	6 (38%)	0 (0%)	5 (33%)	1 (3%)	11 (35%)

of control over a situation that was previously thought to be uncontrollable. Adolescents and parents from both groups expressed the value of early, frequent contact, doubting that their perceived success would have occurred with the usual clinic approach of a 6-month follow-up interval from the initial visit. Most participants in the alone group favored their sessions without parents ("*It's my problem*," "*I can handle it*," "*I figured it out*"). Some participants in both groups noted that if they had parents who were separated, food purchases or the preparation of food varied between households. A participant in the adolescent/parent dyad group felt positive about her parent being in attendance: "*It was helpful with my Mom being there. She was my guide*." Adolescents in both groups valued the adjuncts to learning, such as elastic exercise bands, pedometers ("*I really liked that. I learned about the 15,000 number*" [their goal for the number of daily steps]), websites, printed lists of food substitutions, and cook books. Adolescents in both groups enjoyed having progress reinforced regularly and autonomy respected in their decision making. Some parents in the dyad group described how their child became a role model for their peers, friends, and siblings and proudly reported positive feedback. Interestingly, many adolescents changed the description of their blood test results from "*it*" to "*my*" cholesterol by the end of their interview. Overall, the adolescents from both groups experienced a sense of importance about being in a research study ("*It's like, maybe I can help other people in the future*"), a decrease in teasing or bullying, improved self-confidence, and greater involvement in school sports.

The provider/counselor. Adolescents in both groups described attributes of the MI counselor that resonate with descriptions in the literature. Terms that were repeatedly expressed included "*trust*," "*respect*," "*commitment*," "*supportive*," "*sensitive*," and "*positive*." They also reported that the counselor supported them in goal planning, maintaining focus and control, and for holding themselves accountable ("*She wouldn't let us off the hook*"; "*She really made me want to do a good job*"; "*She understood my challenges*"). The MI counselor was described as an open, honest, non-judgmental, non-critical, empathetic person and the collaborative approach was viewed as the driving force behind their success. One parent from the dyad group noted, "*We were really parenting together*." Reflecting on the qualitative data, three key themes emerged: (1) owning "*it*" (their condition), (2) taking control (of the plans and targets), and (3) "*my choice*" (in making personal choices in lifestyle and outcomes).

Discussion

Adolescent development

This study was informed by a body of evidence for the positive behavior outcomes associated with MI interventions, predominantly in the adult population, on lifestyle change for those with dyslipidemia and overweight and obesity, among other conditions,[46,47] including chronic illnesses in children and adolescents.[46] While the adolescent population with dyslipidemia and overweight or obesity is especially at risk for adult cardiovascular sequelae, they are also faced with unique challenges resulting from their health care and management being in a family-centered care environment where parents are usually the voice for their child.

Adolescent health care is a considerable challenge due to major physiological and complex psychological changes

during this developmental period. Adolescents are at a higher risk of gaining excessive weight and, consequently, cardiometabolic syndrome, which is complicated by their growth and development and changes in the pattern of body fat distribution.[28] This is a critical period for their physical and physiological growth; in male adolescents, fat storage is pronounced in the central area such as the abdomen, while in females, fat deposition is more peripheral in the breasts, hips, and the buttock area.[28] While there were no significant gender differences found, our study noted an overall improvement in adolescents' BMI, waist measurement, waist-to-height ratio, and percentage of fat mass and fat-free mass for both groups combined.

Vascular complications

An association has been reported between arterial stiffness and obesity in adolescents, suggestive of the presence of subclinical atherosclerosis at an early age.[48] There is some debate regarding the impact of obesity on arterial stiffness. One study reported lower pulse wave velocity in those with an elevated BMI,[49] while another study reported that pulse wave velocity increased with higher BMI in children over 10 years of age.[50] These conflicting results may be due to varied demographics of the patient populations under study and the techniques used for measurement. Our results showed no significant changes in pulse wave velocity in the baseline to endpoint comparisons, either within or between groups.

Current study findings

This randomized controlled trial was undertaken to explore whether the use of a MI intervention was more effective when adolescents were counseled along with their parent as a dyad versus the adolescent counseled alone. Following the 6-month MI intervention period, few statistically significant differences were observed for changes between groups. When the combined-group outcomes were explored pre versus post study, statistically significant improvements in outcomes were noted for most measures. Our study found an overall improvement in lipid profile variables for both groups combined, but no improvements in HDL-C or triglyceride-to-HDL-C ratio. Statistically significant findings were observed for total cholesterol-to-HDL-C and HDL-to-total cholesterol ratios among the combined groups. While improvements in lifestyle behaviors likely led to improvements in adiposity and cardiometabolic risk factors, including lipid variables, the magnitude or duration of change was not sufficient to result in an improvement in vascular measures. Although lipid variables are known to have a relationship with early markers of atherosclerosis in children and adolescents,[51] the issue remains underexplored and the findings from this study are not conclusive.

The qualitative component of the study provided rich commentary regarding the adolescents' experience of dyslipidemia and overweight or obesity, their reactions to their condition, and the MI process itself. Greater changes were seen in personal control and taking ownership of the myriad challenges in their lives such as making healthier food choices, assuming responsibility for goals set during MI sessions, and increasing physical activity while decreasing screen time and sedentary behaviors.

The adolescent/parent dyad versus the adolescent alone group design

Parent involvement, role modeling, a positive family environment, and an adaptive attitude (without focusing on weight, per se) are reported to be beneficial when engaging adolescents in health behavior change.[52–54] Our study involved adolescents and parents who agreed to be randomly allocated to receive MI counseling as an adolescent/parent dyad or as an adolescent alone. The parent role is valued in the context of family-centered care, but we were also sensitive to the unique behavioral, social, and emotional attributes of adolescents, and their growing sense of independence. Our hypothesis was that the dyad group would fare better than the alone group and, while there were no between-group differences in the primary outcome, we observed lifestyle changes favoring the alone group (reductions in dietary fats and sugars and in screen time). Interviews at the study endpoint identified that some adolescents worked well with their parents, setting shared targets, and valuing the interaction. Other parents were more authoritative, tending to talk over the adolescent, and viewing any positive outcome as "their" achievement. Those in the adolescent alone group were satisfied with their study allocation, suggesting it was more complimentary to their personalities, their individual parent relationships, and their personal strengths. Our findings are consistent with the current literature, which reports that parents can or should provide a healthy environment and continued support for their child.[55,56] Our results add the important finding that most adolescents in the alone group, with the support offered by MI counseling, felt autonomous and more accountable. Adolescents in the alone group had the ability to learn, choose more favorable lifestyle practices, influence family and peers, and successfully resolve their ambivalence about lifestyle modification.

Although the benefits of family-based interventions have been reported, specific information on family structure is generally missing in the current literature. It is important to determine whether the adolescent is being raised by a single parent or whether they reside in multiple households during this developmental period.[57] In our study, the MI sessions and the study endpoint interviews identified that some adolescents were being raised in two separate, single-parent households, where support may have been discordant.[58,59]

Limitations

The positive outcomes may be attributed to volunteer bias, in that those adolescents consenting to participate may have had a stronger motivation for change at the onset of the study, as indicated by their high scores for "intention" (the contemplation and preparation stages) from the MI Readiness to Change questionnaire (Table 6). While a usual care (control group) was not included in the design of the study, a logical question is whether the MI intervention may be superior to conventional care, that is, our usual clinical practice of an initial visit with a 6-month interval before the next appointment. The Bonferroni adjustment for the pre-/post-analysis of the combined sample was not performed for purposes of this study as our research interests were exploratory and observational in nature. The adapted version of the MI Readiness to Change questionnaire requires further validation. The lack of baseline data for one participant thwarted our planned, intention-to-treat approach to the quantitative analysis. The nurse practitioner as the consistent counselor for both groups strengthened the study's internal rigor and she was careful to avoid bias as the study's principal investigator. Group allocation during the MI sessions was obvious and blinding was not possible; however, non-blinding of the nurse practitioner remains a possible study limitation. Sustainability of the positive outcomes is also of interest, and a longer follow-up duration would be of value. The wide age range (10–17 years) of adolescents may have also influenced the study's findings. Differences in chronological age and developmental skills and abilities related to educational needs, autonomy, as well as social, emotional, and parental support were not examined. In addition, there are known differences in gender related to parental support; however, differences in gender were not accounted for in this study.

Conclusion

MI is a well-established counseling style within a behavior change model and aims to help individuals achieve personal discovery and overcome ambivalence. Facilitating a person's own intrinsic motivation for change is the desired outcome of MI.[25,60] Data on MI interventions for behavior modification in adolescents are emerging, with limited literature on dyslipidemic adolescents.[10,16–18] The findings from this study are consistent with previously reported data on the effectiveness of MI with children.[16–18] In addition, this study makes an important contribution to the understanding of the impact of an MI counseling strategy for behavior change in dyslipidemic, overweight or obese adolescents. Both intervention groups showed significant improvements in their level of adiposity, lipid profile, health behaviors, quality of life, self-efficacy, and self-esteem, with advances through behavioral stages of change. The MI intervention by a trained, consistent counselor was likely a key component to significantly improving outcomes for both groups. The adolescents described their experience of having dyslipidemia as their problem (owning

"*it*"); they preferred to have control (or take control) and also desired autonomy in making personal choices to modify their lifestyle. Most parents from the adolescent/parent dyad group were committed to helping their child make a change and reported their involvement as an "*eye opening experience*" and a benefit to the whole family. They expressed that making changes were "*not as stressful or frustrating [as initially thought]*."

In light of the results and limitations of this study, further research would benefit from a larger sample size, an extended follow-up period, cost considerations, the family context, and an exploration of outcomes by age range and gender. In addition, a more interpretive method for qualitative inquiry would tap into the lived experiences of both the adolescent and the parent within the social context where these behavior changes occur.

Declaration of conflicting interests

Ethical approval

Funding

Informed consent

Trial registration

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