safe animal handling and caretaking practices. Students are then given opportunities to engage in self-directed activities to help care for, and provide enrichment to, the animals. SEL is a central focus of HAEIs each session. Students learn subtle animal behavioral cues associated with animals' affiliative and aversive responses and practice the skills needed to elicit positive, cooperative responses from the animals (e.g., non-verbal communication skills, self and social awareness, boundaries, respect, and responsible decision-making). Supportive adult facilitators encourage students to reflect on their behaviors, emotional intent, and potential effect on the quality of HAEIs during these activities and model social competence and positive behavior. These SEL approaches affect changes in self-regulation competencies (Table 1) that result in the more distal desired clinical outcomes (Figure 1).

The Present Study: Behavioral Regulation in HAEI-Based Interventions

As noted above, ample evidence suggests that HAEIs have broad emotional, cognitive, and behavioral outcomes. Because these interventions are associated with the regulation of stress, distress, and arousal, it is clear that self-regulatory processes are an important mechanism associated with these interventions. We thus propose that HAEI-based interventions, such as those delivered within the Green Chimneys model, provide important contextual assets that contribute to the development of self-regulation skills.

Table 1.
HAEI Intervention Goals

Self-Regulation Competencies	**Processes**	**Intervention Goal**
Emotional Skills	Dynamics of emotions (e.g., shifts from a positive or neutral emotional state to a negative one) produce adaptive or maladaptive responses to the environment.	Reduce emotional distress
Regulatory Flexibility	Repeated or rigid use of one regulatory strategy limits context sensitivity, ability to accurately gauge feedback, and discernment of demands and opportunities in a given context.	Increase adaptive emotion regulation strategies
Attentional Control	Deficits in attentional control reduce ability to inhibit inappropriate behaviors and increase conflict and aggression in relationships	Increase attentional control
Prosocial Behaviors	Difficulty regulating behavior leads to internalizing (e.g., withdrawn, or anxious) and externalizing (e.g., aggressive) behavior problems.	Increase prosocial behaviors

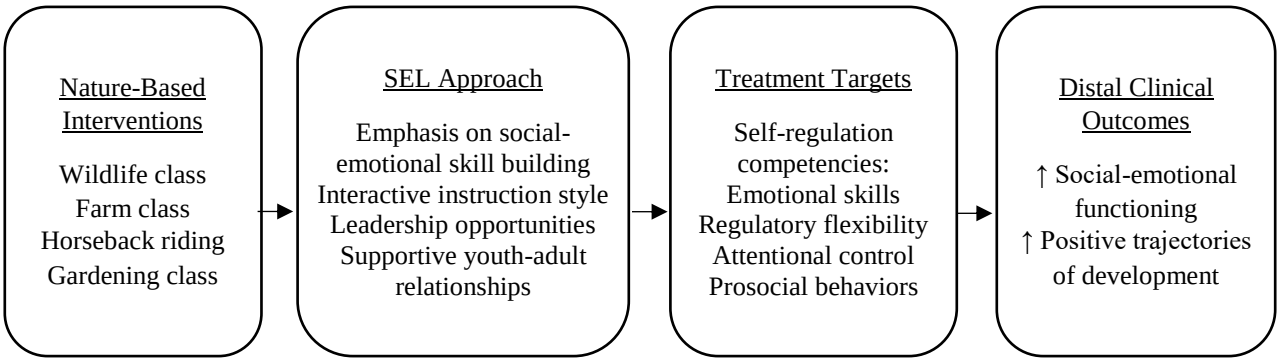

Figure 1. Theory of Change for Green Chimneys HAEI Model

To begin to test the model outlined in Figure 1, this proof-of concept study explores the hypothesis that the Green Chimneys model of HAEI may be linked to self-regulatory processes by using the frequency of student restraints as an indicator of self-regulation. The study compares the prevalence of restraint incidents in the HAEI-settings at Green Chimneys compared to other contexts on campus. As noted above, challenges with self-regulation can manifest in a number of internalizing and externalizing behaviors that may result in restraint incidents, which therefore can be used as a proxy for self-regulatory status. Following standardized guidelines (see Method for additional details), students are only physically restrained if they are considered a danger to themselves or others. Therefore, restraints represent a relatively extreme example of dysregulation, and therefore is a useful proxy for understanding substantial self-regulatory challenges. We hypothesized that there would be lower rates of restraint incidents in the contexts with HAEI experiences (e.g., farm) as compared to those without HAEI elements (e.g., classroom).

Method

Participants

Human subjects' participation in the research was overseen by the University of Denver's IRB (DU IRB Protocol 1000610-6). Participants for this study were 419 students enrolled at Green Chimneys during the 2015-2017 school years. Students identified as 68% (*n* = 285) White, 14.3% (*n* = 60) Black, 4.5% (*n* = 19) Hispanic, 1% (*n* = 4) Asian, and 8.1% (*n* = 34) multi-racial (4.1% missing data). Participants ranged in age from 5 to 17 years of age (*M* = 10 years old), and were 90% male (*n* = 379).

Students had a wide range of primary psychiatric diagnoses including neurodevelopmental disorders (e.g., attention-deficit hyperactivity disorder, attention deficit disorder, autism spectrum disorder, pervasive developmental disorder), adjustment disorders, anxiety disorders, post-traumatic stress, mood disorders (e.g., bipolar disorder, disruptive mood dysregulation disorder), impulsive control disorders (e.g., conduct disorder, disruptive behavior disorder, impulse control disorder, oppositional defiance disorder), and psychotic disorders (e.g., psychotic disorder, schizoaffective disorder). All students entered with more than one psychiatric diagnosis. In addition, over 90% of the population had experienced one or more psychiatric hospitalizations prior to their admission to Green Chimneys and the population averaged 2.5 psychotropic medications. Table 2 provides primary diagnosis data aggregated by type of disorder.

Table 2.
Student Primary Diagnosis

Diagnosis Type	*n* (%)
Neurodevelopmental Disorders	169 (40%)
Adjustment Disorders	7 (2%)
Anxiety Disorders	20 (5%)
PTSD and Trauma Related	21 (5%)
Mood Disorders	149 (36%)
Impulsive Control Disorder	42 (10%)
Psychotic Disorder	9 (2%)
No diagnosis	2 (<1%)
Total	419

Procedure and Measures

Restraints. Green Chimneys staff are trained in the Therapeutic Crisis Intervention model (Holden et al., 2009). Physical restraints are used to ensure safety and are only used when a specifically-trained professional assesses it is necessary. A restraint is defined as "the use of trained staff members to hold a young person in order to contain acute physical behavior (behavior likely to result in physical injury)" (Holden et al., 2009, p. S119). Per the Holden et al. guidelines, restraints are applied with "a maximum amount of caring and a minimum amount of force" in order to reduce stimulation and de-escalate the client's response. An incident report, that includes location of the incident, is generated for each restraint occurrence per New York State and agency requirements (18 CRR-NY 441.17). The number of individual students involved in restraint incidents each year was lower than the number of incidents for that year due to some students accounting for multiple occurrences (Table 3).

Restraint location. Restraint episodes were categorized by location from the incident reports into four groups: school/classroom, structured/non-academic (e.g., gym, occupational therapy), unstructured non-academic (e.g., cafeteria, playground), and farm.

Time in Location. The average amount of time students spend in each area was calculated by using school day scheduling data from 20 randomly selected students (10 day students, 10 residential students). The school day consisted of 1,950 minutes per week (390 minutes per day). Time spent in each of the school locations was calculated for each of the 20 students and used to create average minutes per week and percentage of time spent in each location area.

Results

Of the 419 students enrolled at Green Chimneys during the 2015-2017 school years, 143 (34.1%) were involved in at least one restraint. Table 3 reports the number of students restrained in each location area, stratified by year.

The number of restraints was divided by percentage of time spent in each location area, providing a rate of restraints per time unit for each location. Adjusted for amount of time spent in each setting during a typical day, the rates of restraint were considerably lower for the farm (0.3 restraints/time unit) compared to the school/classroom (278.9 restraints/time unit), structured activities (24.4 restraints/time unit), and unstructured activities (25.7 restraints/time unit; see Table 4).

Table 3.
Number of individual students involved in restraints, by location and year

Location	2015	2016	2017
School/Classroom	50 (52%)	73 (54%)	64 (50%)
Structured/Non-academic	33 (34%)	30 (23%)	30 (23%)
Unstructured/Non-academic	11 (12%)	29 (22%)	32 (25%)
Farm	2 (2%)	1 (1%)	3 (2%)
Total	96 (100%)	133 (100%)	129 (100%)

Table 4.
Restraint incident by location adjusted for time spent during school day (2015-2017)

Location	% Time	Restraints	Restraints/Time	E(Restraints|Time)[a]
School/Classroom	57.5	485	278.9	434.1
Structured/Non-academic	18.5	131	24.2	139.7
Unstructured/Non-academic	19.5	132	25.7	147.3
Farm	4.5	7	0.3	33.9
Total	100	755	329.2	755

[a] Computed as total number of restraints x percentage of time

As a follow-up analysis, we computed the expected frequency of restraints in each location by multiplying the total number of events (755) by the percentage of time spent in each location. A chi-square test of goodness of fit then revealed significant differences between the observed and expected frequencies (χ^2 [df = 3] = 29.49, p < .001). Follow-up pairwise comparisons that examined the frequency of restraints at the farm and each of the other locations (one location per comparison) further indicated significant differences in all models (all p vales < .001).

Discussion

The purpose of this study was to begin to explore the relationship between HAEI and self-regulatory behaviors within the context of the Green Chimneys model. As demonstrated through the demographic profiles, Green Chimneys students represent a sample of youth who are at risk for self-regulatory challenges that can result in internalizing and externalizing behaviors. A physical restraint is indicative of a significant episode of dysregulation, as physical restraints are only employed if students are at risk of injuring themselves or others. As hypothesized, the prevalence of restraints was substantially lower when students were in an HAEI setting (e.g., the farm), compared to more traditional settings such as the classroom.

While these findings are exploratory and limited in scope, they provide initial support for the hypothesis that interventions involving HAEIs may be conducive to promoting adaptive self-regulation. Future research will explore the processes involved in HAEIs and self-regulation, utilizing longitudinal data and more complex measurement approaches to understand the specific interventions that are effective for youth with different diagnostic profiles. Restraint frequency captures the more extreme instances of difficulty with self-regulation, and future research should include measures that capture a wider range of behaviors to more fully understand the role of HAEIs in potentially preventing or de-escalating negative behaviors, as well as supporting positive behavioral regulation. The Green Chimneys model provides an ideal environment for studying these processes, due to the range of diagnoses in their student population as well as their diverse suite of HAEI programming.

More broadly, there are several limitations to existing research on HAEIs as SEL interventions that should also be addressed in future research. A number of AAI studies have demonstrated positive effects on cognitive, social, and emotional development outcomes for youth in school settings (Edenburg & van Lith, 2011; Gee et al., 2017), but the interventions rarely involve components key to successful SEL

programs (e.g., intervention lasting at least nine months; use of evidence-based skills training practices; methods to increase healthy bonding with others; and community-building activities; Catalano et al., 2002, 2004; Durlak et al., 2010, 2011). Further complicating efforts to examine the link between HAEIs and youth development is that these interventions are often incorporated into complex environments that include different types of interventions and varied protocols for their implementation (Davis et al. 2015; Kamioka et al., 2014). In fact, findings from two studies indicate that school-based AAIs have different effects when delivered to individuals at different stages of development. For example, animals may stimulate arousal for younger children (Somervill et al., 2009) while promoting anxiety-reduction for older adolescents (Pendry et al., 2014). Another study found that specific AAIs could, if properly structured for specific student characteristics, be used to achieve such different outcomes as reduced stress while learning, increased cognitive arousal to prime optimal learning, or to enhance social skills training outcomes (Schuck & Fine, 2017). Therefore, the clinical impacts of AAIs appear to vary according to implementation protocols, individual factors (e.g., developmental age and diagnosis), situational differences, and clinical goals.

Given these challenges, future research should develop and refine measurement approaches that can adequately elucidate the role of HAEI-based interventions, such as the Green Chimneys model, in increasing emotion and behavior regulation during adolescence and explore the relationships among HAEI, self-regulation, and PYD within complex treatment and special education environments. The findings presented here support such efforts toward more nuanced understanding of the effects of HAEIs on youth development for both typically developing and clinical populations.

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