

Article

A one-year prospective follow-up study on the health profile of hikikomori living in Hong Kong

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Abstract: Background: A prospective study was conducted to follow-up how the living lifestyle of hikikomori could change the social, mental and physical health profile. Methods: A cohort consisted of 104 young people living as Hikikomori were interviewed at baseline, 6 months and 12 months by using the same set of questionnaires and anthropometric measurements. Results: Besides the high attrition of 30% in wave 2 and 25% in wave 3, almost half of the participants have recovered from hikikomori by returning to the workforce in society. The three domains of health profile of hikikomori were significantly improved over the follow-up period by: 1) increasing the social network scores from 2.79±1.80 to 3.09±1.87, 2) decreasing the perceived stress scores from 21.18±5.87 to 20.11±5.79, and 3) reducing blood pressure levels from 118/75 to 115/71 and waist-to-hip ratios. Those variables were also predictable by lifestyle living with the hikikomori according to the Generalized Estimating Equation analysis, whereas the participants of current study had increased the practice of moderate-intensity exercises. Conclusion: Social work intervention was effective in helping the recovery of hikikomori while physical assessments followed by encouragement from social workers to do more exercises might enhance their awareness in health modification towards a better health.

Keywords: Hikikomori; hidden youth; health; hypertension; obesity

1. Introduction

Our recent study has revealed that the sedentary lifestyle living of hikikomori may lead to poor physical health outcomes, in particular obesity and hypertension [1]. The top solitary activities pursued by those socially-withdrawn young individuals were sedentary in nature, such as surfing the internet, chatting on-line with strangers, and sitting in a corner [2]. The protracted confinement in bedroom could be hard to lead the usual domestic cycle of adequate and regular sleep causing poor sleep quality [1,3]. A recent review has discussed the similarities between hikikomori status and pervasive developmental disorders, which suggested the associations of physical problems such as headaches, neck, back and muscle pains, and gastrointestinal problems with the irregular sleep-wake rhythm of hikikomori [4]. Indeed, from the bio-psychosocial point of view, as supported by empirical evidences, the harmful impacts of socially withdrawn and sedentary lifestyle on both physical and mental health have long been established. A qualitative study has shown that many hikikomori living in Hong Kong were unhappy and having low self-esteem [5]. Numerous studies [6-10] have reported that the existence of psychiatric co-morbidity was common within 1-2 years following the onset of a hikikomori life, and that the problem often became worse during the time that the individual leads

such a life. In Japan, the incidence of mental disorders in hikikomori was almost twice that of the age-matched control population, whereas the risk of mood disorders was six-times higher among hikikomori [7]. Although the etiology remains largely unknown, many researchers believed that this is a personalized phenomenon and culturally driven. In fact, a hikikomori lifestyle could be ideal for many young individuals as a personal choice to withdraw from a life that they feel is stressful. However, as more and more hikikomori cases were being identified in Western [2, 11-12] and Asian countries [7,13-14], the pandemic of “hikikomori” and its possible health consequence has drawn attentions from public health experts worldwide [6,15]. The recent breakthrough in blood biomarkers suggested the biological basis of hikikomori etiology that oxidative stress and inflammation may be involved to cause the respective behavioral and psychological traits [16]. With the first health profile of hikikomori that has recently been established and unclear physiological mechanism, in the present study, the previous cohort was followed up to understand how the social, mental and physical health states of young people who were hikikomori would change in a year duration. Secondly, the incidence of young individuals recovering from the hikikomori life would also be estimated.

2. Materials and Methods

2.1. Participants

The cohort of 104 hikikomori cases as indicated in our previous publication [1] was followed up at 6 months (wave 2) and 12 months (wave 3). The Psychotic Screening Module of the Structured Clinical Interview for DSM Disorders Axis I (SCID-I) was used to screen the participants at each wave to exclude any psychotic and associated symptoms. Participants clinically diagnosed with mood disorders at follow-ups were also excluded. Exclusion of such participants with psychosis and clinical mood disorders, because they might not be able to complete the comprehensive set of questionnaires used in this study. Ethical approval (Reference: HSEARS20151126002) was obtained from the Human Subjects Ethics Committee of the Hong Kong Polytechnic University.

2.2. Procedures of the Follow-up Interviews

Potential participants were approached by their case social workers to make an appointment for interview (normally on the date of home visit) about one month before the study follow-up. On each interview day, the data collector (trained nursing student) followed the respective social worker to their home visits to the potential participants, and conducted the measurements in the absence of the social worker immediately after their consultation. Psychotic status was first screened with the SCID-I and none of the participants were identified to have clinical significant psychotic symptoms. Eligible participants were then proceeded with physical measurements and completing a set of self-administered questionnaires. The interview lasted around 45-60 minutes. A cash voucher was given to each participant at the end of each interview as a token of appreciation. The data collectors were trained and found competent in administering the semi-structured SCID-I instrument and demonstrated with very satisfactory inter-rater reliability of the screening and questionnaire administration.

2.3. The Instrument and Anthropometric Measurements

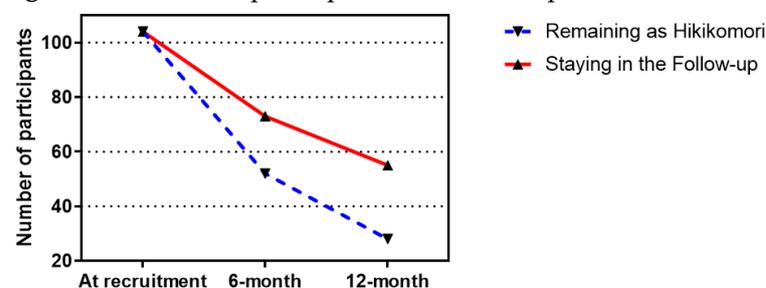
The instrument consisted of the same set of questionnaires used at the baseline was used [1]. In brief, the socio-demographics section captured information about any changes in financial condition, smoking habits, usual daily activities pursued such as surfing the Internet, reading comics, and watching animation. Mental health was measured by using the Chinese 10-item Perceived Stress Scale (PSS-10), the Chinese Beck Depression Inventory-II (BDI-II), and the Chinese State Anxiety Scale of State-Trait Anxiety Inventory (STAI-Y1). The Chinese 10-item Perceived Stress Scale (PSS-10) instead of PSS-14 was used for assessing the degree to which hikikomori individuals perceived their lives as stressful. Such change was suggested by the observation of the baseline study that the PSS-10 scores were consistently compatible to the PSS-14 scores in hikikomori, and hence 4 items were removed to shorten the instrument length. The lifestyle section mainly evaluated the degrees of

distortion on way of living using the Chinese Godin Leisure-Time Exercise Questionnaire (GLTEQ), the Chinese Pittsburgh sleep quality index (PSQI), the “How healthy is your diet? Questionnaire” [17]. The social health section included the Berkman-Syme Social Network Index (SNI) to measure social connectedness, and the Chinese Family Environment Scale (CFES) to assess the three key dimensions, namely cohesion, expressiveness, and conflict. Since the Dietary questionnaire and SNI questionnaire were not available in Chinese, the English versions were translated and back-translated into Chinese by two bilingual professional translators. Whilst the physical health was assessed by the Chinese SF-36 Physical Functioning Subscale (PF-10), in addition to a series of anthropometric and physical measurements, according to the methods described previously [1]. The systolic blood pressure (SBP) and diastolic BP (DBP) values were measured twice each 5-10 minutes apart using the automatic oscillometric blood pressure monitor (Microlife BP A200 AFIB, Switzerland), and the average value was taken. The mercury sphygmomanometer-and- stethoscope method was used to take two BP measures (each at least 5 minutes apart) in case of a discrepancy over 10% between the two BP readings.

2.4. Statistical Analysis

Data collected in this study were analysed using IBM SPSS Statistics 22.0. Frequency and percentage were computed for each of the binary or categorical variables, whereas mean and standard deviation (SD) were computed for continuous variables. Together with the anthropometric variables measured in this study, the composite scores were computed for all subscales of the instrument according to the subscale scoring schemes, and expressed as mean and SD. Missing data was replaced by the last observation carry forward method. Those continuous variables were compared across different time points (3 waves) using the Repeated Measures Analysis of Variance (ANOVA). RMANOVA was used to examine the changes over the 3 waves, whereas the F values and imputed p-values were reported. Additionally, Generalized Estimating Equation (GEE) was performed as an alternative method for RMANOVA to see whether the trend is significant or not.

Figure 1. Number of participants at each time point.



3. Results

3.1. The follow-up cohort

From March 2017 to June 2018, the cohort of 104 hikikomori that reported with the baseline health profile (wave 1) [1] was followed up. As shown in **Figure 1**, within the 12-month follow-up period, 73 and 55 participants had stayed in the study with completion of the set of questionnaires in addition to all anthropometric and physical measurements at 6 months (wave 2) and 12 months (wave 3), respectively. An overall number of 53 participants (51.0%) had completed the measurements in all three waves. whereas the attrition rates were recorded as 29.8% in wave 2 and 24.7% in wave 3. Besides, a significant portion of the follow-up population has recovered from the hikikomori by returning to the workforce in society. In particular, only 52 (71.2%) and 28 (50.9%) of participants remained as hikikomori in wave 2 and wave 3, respectively (**Figure 1**).

Table 1. The significant social, psychological and physical health variables of identified in hikikomori followed up for one year.

Variables	Wave 1	Wave 2	Wave 3	RMANOVA	(Imputed)	GEE		
	(n=104)	(n=73)	(n=55)					
	Mean±SD			F	p-value	Beta	p-value	
Social	SNI score	2.79±1.80	2.93±2.06	3.09±1.87	12.174	<0.001	0.275	0.009
	ISEL total score	24.60±6.30	24.63±5.99	24.75±6.89	1.074	0.302	0.269	0.493
	Appraisal	6.81±2.16	6.90±1.87	7.11±2.18	2.463	0.096	0.170	0.267
	Tangible	6.20±1.71	6.29±1.53	6.20±1.73	0.618	0.496	-0.010	0.933
	Belonging	6.00±2.45	5.89±2.53	6.05±2.44	2.343	0.104	0.136	0.342
	Self-esteem	5.59±2.08	5.55±2.14	5.38±2.39	0.544	0.577	-0.052	0.685
Psychological	Perceived stress	21.18±5.87	20.18±6.25	20.11±5.79	3.437	0.045	-0.709	0.028
	Depression	17.17±11.49	16.48±10.87	15.76±11.80	1.327	0.265	-0.658	0.241
	T-anxiety	44.22±12.17	46.48±12.97	42.45±11.16	2.105	0.131	-0.621	0.291
Physical	SBP (mmHg)	118±16	117±15	115±13	0.955	0.386	-1.212	0.108
	DBP (mmHg)	75±10	73±9	71±9	10.223	<0.001	-2.058	<0.001
	Waist circumference (cm)	77.64±16.87	76.26±12.13	76.37±15.44	2.043	0.138	-0.643	0.050
	Waist-to-hip ratio	0.82±0.09	0.81±0.75	0.81±0.09	3.967	0.024	-0.009	0.012

3.2. Improvements in the health profile and lifestyle practice

During the one-year follow-up period, the states of all three health domains were improved in the studied cohort. Four continuous outcome variables representing three different health domains, namely SNI score, PSS-10 score, DBP and waist-to-hip ratio were shown to be statistically significant across the three waves, as analyzed by the Repeated Measure ANOVA (**Table 1**). Socially, the network index score (SNI) was gradually elevated ($p < 0.001$) by 5.0% in wave 2 and 10.8% in wave 3 as compared with the baseline (Table 1). This indicated that the participants were lesser and lesser socially isolated. However, no significant change was observed in the total interpersonal support score (ISEL) and any of its four subscales. Regarding the mental health, the perceived stress levels (PSS-10 scores) of participants were significantly reduced across the three waves (**Table 1**). As compared with the baseline, the number of moderate stress was reduced from 74% to 67% in wave 2 while the number of severe stress was reduced from 16.3% to 12.7% in wave 3 (data not shown). A decreasing trend was also observed in the depression levels, although statistically significant (**Table 1**). Particularly, the percentage of participants with depression at moderate level or above was remarkably decreased from 37.4% at baseline to 31.5% at wave 2 and 30.9% at wave 3. However, no significant change was shown in the trait anxiety scores and maintained at the moderate level during the entire follow-up period.

Physically, the blood pressure levels of participants were gradually diminished across the three waves, especially for the DBP that has achieved statistical significance $p < 0.001$. Similar reducing trend was also observed for the SBP, making the reduction of SBP/DBP of 118/75 (SD=16/10) at baseline to 117/73 (SD=15/9) at wave 2 and 115/71 (SD=13/9) at wave 3 (**Table 1**). According to the JNC7's classification, as compared with the 15.4% (141/91; SD=10/5 mmHg) and 31.7% (126/79; SD=9/5 mmHg) of the baseline, the percentages (and mean BP levels) of hypertension and prehypertension at the end of one-year follow-up were 9.0% (138/85; SD=14/7 mmHg) and 29.1% (124/76 SD=8/7 mmHg), respectively. Specifically for the single case of type 2 hypertension (171/93) reported at baseline, his blood pressure status was remarkably improved to the JNC classification of stage 1 hypertension (151/80) at wave 2 and further to prehypertension (126/87) at wave 3. None of the hypertensive cases identified in this study was found to have a positive AFIB. On the other hand, statistically significant reduction ($p = 0.024$) was shown in the waist-to-hip ratios of participants throughout the follow-ups, which was consistent with the decreasing trend of the waist circumference (**Table 1**). The percentage of participants with waist circumference above the cut-off that suggested health risk was reduced from 26.9% at baseline to 20.5% at wave 2 and 23.6% at wave 3. However, no significant changes were identified in other measured obesity indexes. Nonetheless, GEE analysis indicated that the above four significant health outcomes (namely social network, perceived stress, diastolic blood pressure, and waist-to-hip ratio) were also shown to be consistently predictable by the everyday lifestyle of hikikomori (**Table 1**).

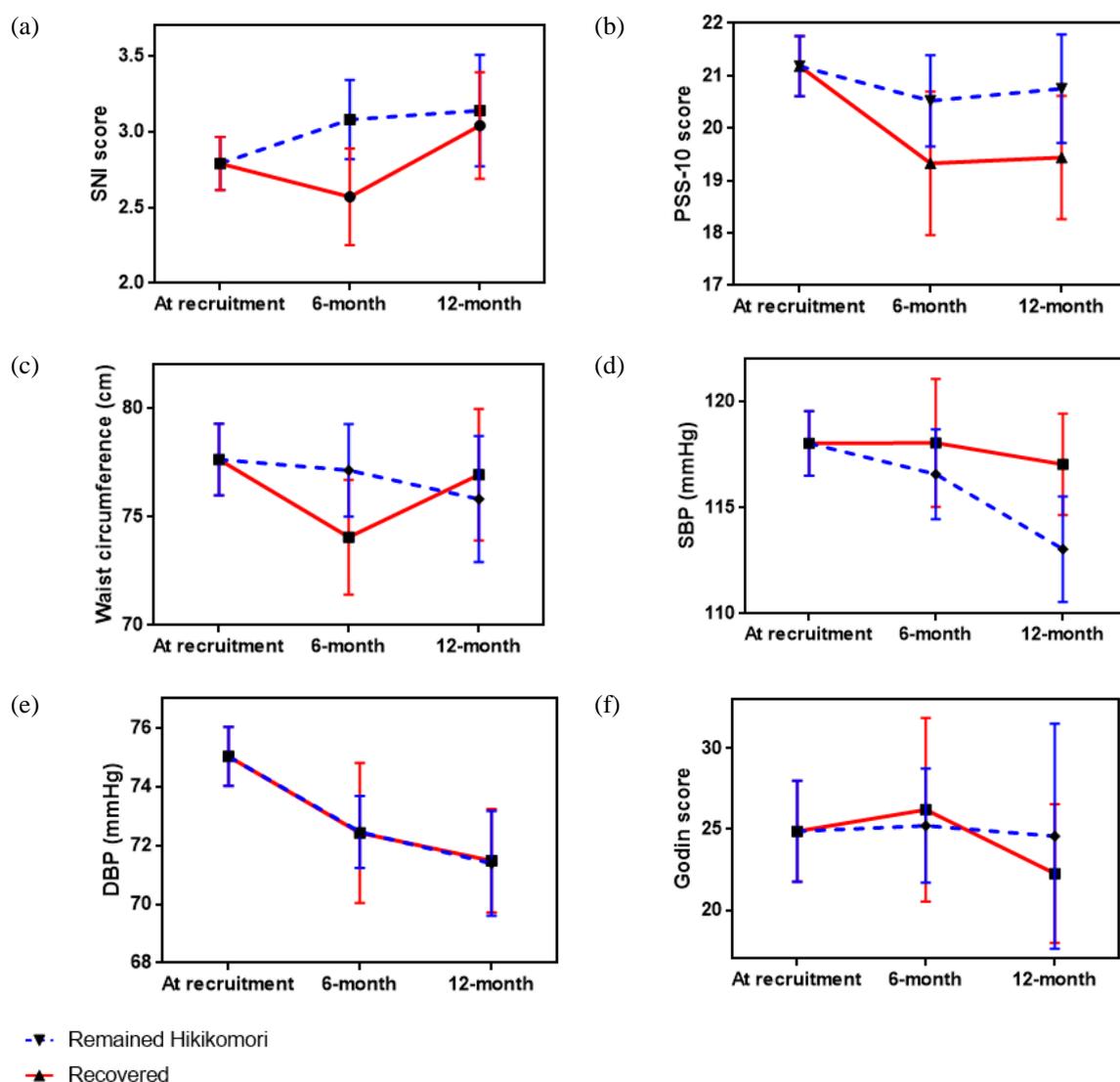
Table 2. A summary of lifestyle measurements in hikikomori followed up for one year.

Variables	Wave 1	Wave 2	Wave 3	RMANOVA F	Imputed p-value	GEE	
	Mean±SD					Beta	p-value
PSQI score	6.57±2.98	7.44±6.24	6.45±2.97	1.622	0.208	0.009	0.953
Weekly Leisure Activity	24.88±31.81	25.51±25.42	23.44±30.31	2.731	0.081	0.826	0.638
Healthy Eating score	12.57±4.85	12.21±5.22	12.25±4.98	0.200	0.813	-0.017	0.928

The daily activity records indicated that the participants spent less time staying at home (19.11±4.40 at baseline vs 18.01±5.16 in wave 2 vs 17.47±4.36 in wave 3; hours per day). When staying at home, they also spent less time in activities such as eating, using computer, and reading books and comics over the three waves. Whilst no changes were observed in hours for sleeping, watching TV, idling and facing the wall but increased mildly the hours for mobile phone or tablets (3.11±5.03 at

baseline vs 4.00 ± 4.52 in wave 2 vs 3.88 ± 3.65 in wave 3). However, as summarized in **Table 2**, no significant differences were identified across the three waves in the three continuous variables of lifestyle practice representing sleep quality, physical activity level and healthy eating habits. Particularly, when compared with that of 74.0% at baseline, fluctuations were observed the percentage of poor sleeper in the two follow-ups with 78.1% (increased) in wave 2 and 70.9% (decreased) in wave 3. Despite the overall weekly leisure activity scores and physical activity levels were not significantly changed among the participants, an increasing trend was observed in the frequency of moderate-intensity exercises over the three waves (from 1.38 ± 2.32 to 1.53 ± 2.82 then 1.55 ± 2.38 times per week). Particularly in wave 2, the frequency of light activity was also notably increased from 3.12 ± 3.27 to 3.73 ± 3.77 times per week. These results suggested that some participants might have improved at least slightly their lifestyle practice towards a better health outcome.

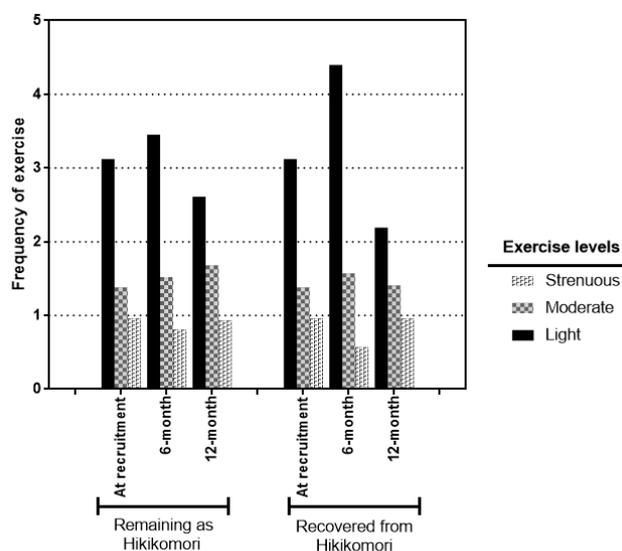
Figure 2. Comparison of the pattern changes among significant variables between the participants remained as hikikomori and those recovered from hikikomori.



As mentioned above, up to half of the participants have recovered from hikikomori and returned to the workforce in society. How the conditions of health improvement of hikikomori were differed from those who have recovered? Among the significant health outcomes identified in Table 1 above, the two subgroups followed similar trends of changes across the three waves (Figure 2). More dramatic increase in SNI scores (Figure 2a) and decrease of waist circumferences (Figure 2c) and SBP

levels (Figure 2d) were observed in the participants remained as hikikomori. However, the decreasing trend of PSS-10 scores in those recovered from hikikomori were more dominant than those remained. The DBP levels decreased at the same multitude across the time points (Figure 2e). Whilst the Godin exercise scores were steadily unchanged among those remained as hikikomori, but the amount of physical activities of those recovered from hikikomori were slightly increased in wave 2 then remarkably decreased in wave 3 (Figure 2f). To take a closer look into the strength of exercises being practiced by the two subgroups, in **right panel of Figure 3**, participants recovered from hikikomori have superseded the strenuous activities by practicing the moderate and light exercises in wave 2 while the practice of light exercises was dramatically reduced in wave 3. On the contrary, participants remained as hikikomori have gradually increased the practice of moderate exercises across the three waves while maintained in balance by adjusting the frequency of light and strenuous exercises (**left panel of Figure 3**). Recovery participants have spent less time staying at home but did not show to have better sleep quality or healthier eating habits than those remained as hikikomori.

Figure 3. The frequencies of different intensity levels of exercise practiced by participants remained as hikikomori and those recovered.



4. Discussion

This was the first study conducted to observe the longitudinal changes in health profile of the hikikomori, particularly in Chinese population. In the studied cohort, improvements were observed in all three health domains across the three waves over one-year period. Such favorable health changes were identified as significant outcomes that were predictable by the lifestyle behavior of the participants, in terms of 1) socially with increasing social networks, both online and offline, 2) mentally with decreasing perceived stress levels, and 3) physically with reducing blood pressure levels as well as waist-to-hip ratios. Secondly, during the follow-up period, about half of the participants have recovered from hikikomori and returned to the workforce or to training/study in society. However, the observed remarkable improvements of health outcomes were dominated by participants who remained as hikikomori but in consistent trends with those who recovered. This phenomenon may be explained by the gradually swapping of exercise practices from light to moderate level strength while no other significant lifestyle modifications were identified.

As reported in our previous study, a number of health manifestations associated with hikikomori, such as hypertension and obesity could be at least partially contributed by their sedentary lifestyle [1]. This causes the postulation of worsening the hikikomori's health conditions by living longer with the length of such lifestyle. However, results of this longitudinal study were seemed to be opposite to such assumption, whereas certain degrees of improvement were observed

in the health profile of hikikomori throughout their one-year living course. Regarding the social and mental aspects, the majority of participants were still displaying the asocial and psychological characteristics commonly observed in hikikomori after a year, although improving trends were observed in social networks and all negative emotional states [2,15,18]. In particular, the significant reduction of perceived stress was mainly associated with those recovery participants, which requires further investigations. The underlying explanations could be something related but not limited to financial burdens, family conflicts and personal satisfaction [19-21]. On the other hand, more surprisingly, the prevalence of hypertension was significantly reduced from 15.4% to 9.0% in 12 months, which was below the 12.6% adult prevalence of diagnosed hypertension [22] and the 12.8% age-specific prevalence for young people aged 15-34 [23] that have been reported in local studies. Cohesively, the prevalence of prehypertension prevalence was also dropped from 31.7% to 29.1%, although mild. Local age-matched prevalence was unavailable for comparison since prehypertension was rarely investigated amongst the younger populations; however, the current prevalence was below the 42.7% prevalence reported amongst the older adults at age ≥ 35 [24]. The combined prevalence of hypertension and prehypertension (i.e. 38.1%) was still alerting, where the risks of transiting prehypertension into hypertension and other cardiovascular complications and metabolic disorders have been well documented [5,24-26].

Could such health improvements be explained by any changes of the living lifestyle? No significant lifestyle changes were observed over the study period, except for the upward trend of practicing moderate-intensity exercises. The joint guidelines of World Health Organization and International Society of Hypertension [27-28] suggested the importance of lifestyle modifications for management of hypertension, in particular weight control by means of physical activities was regarded as the most effective. This notion has agreed with the current observed profile with both reduced blood pressure levels and waist-to-hip ratios. Endurance exercise training was known to be effective in 80% of hypertensive individuals to lower both systolic and diastolic blood pressures significantly [29]. Accumulating evidence suggested effective hypertensive management required exercises at least at moderate intensity [30-31]. This supported the notion to correlation between the reduction of blood pressure and increase of moderate-intensity exercise as observed in this study. Furthermore, the reduction in diastolic blood pressure was shown to be more significant than the reduction in systolic blood pressure in the studied cohort. Hypertension occurring at younger ages are more commonly belonging to the isolated diastolic type, because an increase of systolic BP is often caused by changes of arterial stiffness that should be more frequently happened with aging but unexpected at younger ages [32-33]. Studies also indicated that psychological distress such as job strains were found to be a risk factor for hypertension that is dominant with the increase of diastolic blood pressure [34-35]. Together with the increased practice of moderate-intensity exercises, the reduction of perceived stress in the studied cohort may provide a reasonable explanation on the decreased blood pressure and hypertensive prevalence.

As this was a cohort study, health promotion and education were not provided by the researchers. In fact, all participants were recruited through the case social workers who had been providing them ongoing counseling and psychosocial social support. Those case social workers had the primary goal to find jobs or study opportunities for their clients and get them ready to return back to the society in a gradual and voluntarily manner. Almost half of the participants have returned to the workforce or study institutions within a year time, which indicated that social work intervention was effective. However, would there be other outcome parameters that would be affected by the involvement of social workers? As previously mentioned, empirical physical assessments included in this study were not only beneficial in objective measurements to strengthen the evidence, but it was also found to be important to raise the interest and awareness of participants to be more concerned with their health or at least to adopt a less "hikikomori-type" lifestyle. According to the "health belief model", which places an important emphasis on the awareness of the threat perception (risk) is the key to trigger a series of consequences that lead to the appropriate action, which was effective in predicting the health behaviors [36-37]. The adoption of less sedentary lifestyle by staying less at home and practicing more moderate-intensity exercises were clearly an action taken by the participants even though quite a large proportion of the participants still lead a

secluded living style yet characterized by an increasing level of activities and exercises performed at home. And this action could be at least related to two experiences: 1) The participants were informed of the outcomes immediately after the physical assessments by the nursing researcher, which triggered their awareness and they were looking forward to having the next round of follow-up assessments [38]; and 2) As described by certain social workers, they would care about the health of their clients but they were not healthcare workers, therefore, they played a role of caregiver to remind their clients to live healthier by doing more exercises. The case social workers opined that doing health assessments at the participants' home or in social work service centres had become an attraction in terms of encouraging them to step outside their comfort zone if not safe cocoon which has de-skilled their ability and lowered their confidence to interact with others face-to-face in the non-virtual community [39-41]. Another unintended yet positive outcome was the action taken by the social workers to make the most of the archived health records given to each of the assessed participant as an explicit gentle reminder for doing more exercises at home and loitering around the neighborhood community so as to make improvement in their next wave of health assessment. This implies that there is room for promoting inter-disciplinary collaboration across healthcare and social care sectors not only for the sake of doing empirical research studies but also for opening up a window of opportunity for re-engaging marginalized and invisibilized hikikomori at a pace they find comfortable.

There are, however, several limitations in this study. Because of the hidden nature of the target participants who are one of the hardest groups for engagement and rapport building following their protracted period of seclusion at home, subject recruitment is considered as the most difficult part of the study. It caused the small sample size and high attrition rate as a major limitation. However, the sample size was sufficiently enough to achieve statistical significance when certain measured variables were compared. Furthermore, although participants of this study were recruited from multiple centers, sampling through a single agent i.e. social work is also considered as a major limitation because many hidden cases still could not be reached and sampled. It is suggested that in future studies, other agencies such as secondary schools, student residency of universities, family-based services, medical units, and relevant online forums can also be approached for sampling.

5. Conclusions

Hikikomori lifestyle was largely sedentary in nature that could be a risk behavior, but a longitudinal study has observed improvements in all three domains of the health profile, namely social networks, perceived stress, and blood pressure levels (especially the diastolic blood pressure). The reduction of blood pressure levels and prevalence were consistent with the reduction of waist-to-hip ratios as well as the increase of moderate-intensity exercise over the follow-up period. Whilst the reduction of perceived stress was more specifically associated with the participants recovering from hikikomori, physical assessments followed by encouragement from social workers to do more exercises might enhance their awareness in health modification towards a better health. There is implication for promoting inter-disciplinary collaboration across healthcare and social care sectors for conducting further empirical studies and delivering engagement interventions at a pace that secluded and marginalized hikikomori find comfortable.

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Author Contributions: The research team designed the study and share equal contributions. John W. M. Yuen is the project leader who has supervised the project and finalized the manuscript. Victor C. W. Wong and Ka-Wing So coordinated with all collaborative social service teams to enable the sampling and data collection, and the former or second-author also helped write up the manuscript. The epidemiologist Wilson Tam contributed in the finalization of the data analysis and presentation of the results. Wai-Tong Chien mainly responded in the

constructs and validation of the instruments for measuring different variables. All authors have read the manuscripts and agreed with the contents.

Conflicts of Interest: The authors declare no conflict of interest.

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