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Trend Analysis of Grow-Your-Own Using Social Network Analysis: Focusing on Hashtags on Instagram

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ABSTRACT

Background and objective: The prolonged COVID-19 pandemic has had significant impacts on mental health, which has emerged as a major public health issue around the world. This study aimed to analyze trends and network structure of 'grow-your-own (GYO)' through Instagram, one of the most influential social media platforms, to encourage and sustain home gardening activities for promotion of emotional support and physical health.

Methods: A total of 6,388 posts including keyword hashtags '#gyo' and '#growyourown' on Instagram from June 13, 2020 to April 13, 2021 were collected. Word embedding was performed using Word2Vec library, and 7 clusters were identified with K-means clustering: GYO, garden and gardening, allotment, kitchen garden, sustainability, urban gardening, etc. Moreover, we conducted social network analysis to determine the centrality of related words and visualized the results using Gephi 0.9.2.

Results: The analysis showed that various combinations of words, such as #growourrownfood, #growourrownveggies, and #growwhatyoueat revealed preference and interest of users in GYO, and appeared to encourage their activities on Instagram. In particular, #gardeningtips, #greenfingers, #goodlife, #gardeninglife, #gardensofinstagram were found to express positive emotions and pride as a gardener by sharing their daily gardening lives. Users were participating in urban gardening through #allotment, #raisedbeds, #kitchengarden and we could identify trends toward self-sufficiency and sustainable living.

Conclusion: Based on these findings, it is expected that the trend data of GYO, which is a form of urban gardening, can be used as the basic data to establish urban gardening plans considering each characteristic, such as the emotions and identity of participants as well as their dispositions.

Keywords: social network analysis, Instagram, grow-your-own (GYO), urban gardening, hashtag

Introduction

According to the Korean Quality of Life 2020, life satisfaction that represents the cognitive aspects of subjective well-being such as obesity and suicide rates that are related to mental health, as well as positive emotions measuring when, how much, and how often one was 'happy' and negative emotions measuring when and how much one was 'worried' and 'depressed' all deteriorated compared to the previous year,

thereby proving that the overall life satisfaction subjectively perceived by citizens has decreased (National Statistical Office, 2021). Life satisfaction is how individuals accept or are satisfied with their living conditions, indicating their subjective satisfaction with life. This is closely related to not only an emotionally stable and happy state but also health (Moon et al., 2017).

Interest in quality of life such as 'satisfaction' or 'happiness' has been shown in various activities to increase welfare

services and improve quality of life, and contact with plants through horticultural activities positively improves physical, mental, emotional, and psychological state. Growing plants help heal mental illnesses such as depression and anxiety. Living in or near green spaces and spending as much time as possible in gardens or with nature reduces negative emotions such as stress, promotes physical activities, improves cognitive skills, and reduces aggression, improving overall well-being of people of all ages from various environments (Smith, 2021; Thompson et al., 2012; Hall and Knuth, 2019; Capaldi et al., 2014).

Kim et al. (2010) reported that merely watching videos with natural landscape activated regions of the cerebrum related to positive emotions. Erzsebet et al. (2014) analyzed that arranging plants in workplaces for air purification not only reduces allergies, irritations, asthma, and drowsiness but also positively changes emotions, thereby improving productivity and attention of employees. Moreover, Vaz et al. (2005) stated that gardening activities burn the same calories as aerobic exercises at a gym, thereby contributing to physical health. Bhasin et al. (2013) discovered that being regularly exposed to plants or nature for a short time promotes discharge of adiponectin, which is an antidiabetic hormone, and regulates insulin.

As such, the benefits of making contact with green spaces or plants are perceived as the key to solve social problems regarding quality of life, education, and public health, thereby attaching importance to green spaces and urban agriculture. Park and Lee (2012) raised the possibility of leisure activities to obtain multiple values for mental and physical recovery from exhausting urban life by obtaining the pleasure of crop cultivation, happiness of sharing the cultivated crops, and opportunity to encounter nature with increasing interest and activities regarding urban agriculture. Kim et al. (2012) discovered that the sound of watering plants (hearing), colors or shapes of flowers and vegetables (sight), fragrances (smell), and contact with soil or tools like farm equipment (touch) stimulate the brain, awaken consciousness, and improve attention and memory. Repeating and sharing these activities improved the quality of life for the elderly or people with mental and physical disabilities.

Urban agriculture such as home gardening began to receive attention as an activity for emotional support and physical health of people feeling depressed by the ongoing social distancing due to the prolonged COVID-19 pandemic. According

to the 'Changes in the US Consumption Trends Brought by COVID-19' by KOTRA (2020), gardening activities such as 'grow your own' (GYO) vegetables help people enjoy gardening as a hobby and feel rewarded while staying at home and grow the vegetables and fruits they need on their own. Thus, it has become a key element to maintain a healthy life at home during the COVID-19 pandemic.

Keeping pace with this trend, various studies have been conducted such as a survey on the increase in home gardeners before and after COVID-19 (Mullins et al., 2021) or a study on home gardening among the elderly during COVID-19 lockdowns and how it is related to subjective mental and physical well-being (Corely et al., 2021). However, there is insufficient research on how GYO and related words are shared and communicated online. In particular, as deterioration of mental health has emerged as a severe public health problem due to the uncertainty that COVID-19 will ever end, studies must be conducted to encourage and maintain home gardening activities like GYO to help mental stability. Therefore, this study is conducted to analyze the correlation among words related to GYO on social media where real-time global communication is possible and how these keywords are used and shared among home gardeners, thereby identifying the general trend and providing the basic data to set the direction for development of urban agriculture.

Research Methods

Theoretical background

Grow your own (GYO)

The term 'grow your own' first began to be used in the Defence of the Realm Act to grow vegetables for self-sufficiency by the UK that had been depending 80% of food on import during World War I when the supply discontinued with the blockade of Germany. This was also encouraged in World War II with the campaign 'dig for victory' to produce relief crops to cover military expenses and increase the nation's self-sufficiency rate of food. This is when 'victory gardens' first appeared. The GYO movement carried forward since 2009 is aimed at recovering the quality of life for British citizens deteriorated by economic crisis by encouraging them

to grow and produce their own food in the garden, thereby reducing household burden, managing health and improving the environment through gardening activities, and restoring the local community (Jung, 2018). With the COVID-19 pandemic, this campaign is actively carried out around the world including the UK and US for promotion of physical and mental health and sustainable food production.

In particular, the prolonged pandemic is increasing food anxiety in urban centers due to lack of workforce, cutoff of food supply chain, and limited access, thereby emphasizing the importance of self-sufficiency in producing and consuming food at home and within the society (Lal, 2020). Home vegetable gardens promote physical and mental health through physical activities, reduce expenditures through self-sufficiency, and lead to environmental protection related to sustainable use of natural resources, thereby providing psychological, economic, and production benefits (Sofo and Sofo, 2020).

Social network analysis

Social network analysis is a measurement technique that analyzes and visualizes relationships and relational characteristics among entities such as people, groups, and data using the graph theory in mathematics. It is mostly done with text mining, identifying and analyzing the context of connections along with diffused contents (Telecommunications Technology Association). Networks are represented by nodes and links. Various combinations of these two form different types of network structures. There are weak ties and strong ties among nodes depending on the characteristics and attributes of links. Whether nodes are influential or not can also be determined by how many links they have, and depending on the structure of links, it is also possible to find out whether the nodes mediate different groups or affect diffusion (Kim, 2020).

Centrality, which is an indicator that represents the relative importance of nodes, can be classified into degree centrality, betweenness centrality, eigenvector centrality, and closeness centrality. Degree centrality represents the links to other nodes and is measured by the number of nodes connected to one node (Wasserman and Faust, 1994). Betweenness centrality measures how well one node performs the role as a mediator in building network relations among other nodes (Kwahk, 2017). Eigenvector centrality is a useful indicator in finding central nodes that are most influential within the network, representing the connection reflecting the weight on the centrality of other nodes directly linked to the relevant node (Kim, 2017a). Closeness centrality represents the degree of how close each node is to other nodes and is measured as the inverse geodesic distance between one node and all other nodes (Kim and Kwahk, 2013).

Methods

Data extraction and purification

A typical image-based social networking service (SNS) Instagram is used as a tool for more enriched indirect experience through images in addition to users' search of lifestyle-related trends by immediately obtaining information they want through hashtags (#) (Heo and Yun. 2020; Yoon and Ryoo. 2019). Accordingly, this study used hashtag search on Instagram with the biggest number of users among social media to collect related keywords and identify the trend related to GYO.

First, we used Selenium and BeautifulSoup library on Python 3.9 (Pycon, USA) for data collection and collected 6,732 posts including hashtags '#gyo' and '#growyourown' on Instagram from June 13, 2020 to April 13, 2021. We eliminated 335 redundant data and selected total 6,388 posts for analysis. Since hashtags have no spacing and are tokenized, they can be used to analyze the user attributes as they are (Heo and Yun, 2020), and thus they were selected as final hashtags after embedding without morphological analysis.

Analysis method

Related word network analysis based on co-words is a methodology that builds and analyzes a network of related keywords by extracting words that co-occurred with specific terms (Kang, 2010). To check the major keywords related to 6,388 cases of purified data 'GYO', we used Word2Vec (word embedding to vector), a machine learning word embedding model of Gensim library developed by Google. Word2Vec finds the correlation between words and expresses word data in vector values (Park and Byun, 2021). When vectorizing words, the contextual meaning of words can be preserved and the distance between them can be measured. In Word2Vec, there is the CBOW (Continuous Bag of Words) model that divides all words in a sentence and finds the correlation with sur-

rounding words and the Skip-Gram model that extracts words by predicting surrounding words based on the center word (Park and Byun, 2021; Mikolov et al., 2013).

This study analyzed related keywords by setting the parameters as vector size 300, window size 5, min count 100, and iter 100 using Skip-Gram of Word2Vec. The dimension of the word vectors is 300 (vector size 300), and there are 5 words behind and 5 words ahead of the center word (window size 5) to be scanned, with a minimum of 100 frequency counts (min count 100) and iteration of 100 times (utter 100). Then, clusters with similar characteristics were formed using K-means clustering, and NetworkX library was used to conduct social network centrality analysis. The results were visualized using network analysis visualization software Gephi 0.9.2 (Fig. 1).

Results and Discussion

Related keyword extraction and clustering

Total 6,388 content hashtags collected with '#gyo' and '#growyourown' as keywords from June 13, 2020 to April 13, 2021 were embedded with the Word2Vec model, extracting total 118 related keywords. Word2Vec expresses words in vectors considering the meaning of the words and their context in the sentences, and thus the extracted related words have similar meanings and are differentiated from the top keywords in frequency analysis (Kim et al., 2019; Heo and Yun, 2020).

Among the top 30 related keywords, the one with highest frequency was gyo (5,936), followed by growyourown (3,183), allotment (2,611), gardening (1,951), and growyourownfood (1,904) (Table 1). These words are keywords that represent emotions and trends, such as what contents and activities are shared by GYO participants and what they feel. Hashtags that indicate GYO such as growyourownfood and home-grown were ranked at the top, and there was also high
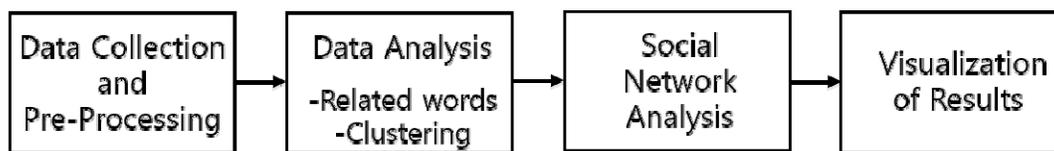
Fig. 1. Data Analysis Flowchart.

Table 1. Top 30 frequent hashtags from related word analysis

Rank	Hashtag	Freq[z]	Rank	Hashtag	Freq	Rank	Hashtag	Freq
1	GYO	5936	11	Allotmentuk	1232	21	Flower	727
2	Growyourown	3183	12	Ediblegarden	1096	22	Gardenersofinstagram	719
3	Allotment	2611	13	Organicgardening	1063	23	Veggiegarden	714
4	Gardening	1951	14	Allotmentlove	1047	24	Vegetables	666
5	Growyourownfood	1904	15	Allotmentgarden	998	25	Gardener	634
6	Allotmentlife	1783	16	Growwhatyoueat	941	26	Urbangarden	555
7	Kitchengarden	1593	17	Organic	878	27	Mygarden	494
8	Homegrown	1489	18	Eatwhatyougrow	821	28	Greenthumb	433
9	Garden	1338	19	Allotmentsofinstagrm	786	29	Nature	403
10	Vegetablegarden	1287	20	Gardenlife	771	30	Greenhouse	397

[z]Freq: Frequency.

frequency of words related to gardens and gardening activities mostly cultivating edible herbs and vegetables, such as gardening, kitchengarden, ediblegarden, organicgardening, and vegetablegarden. Moreover, there were many contents related to urban gardening such as allotment, allotmentuk, allotmentlife, and alootmentgarden. One thing to note is that tags representing pride in the identity as a 'gardener' were extracted as related keywords, such as gardensofinstagram, gardener, and greenthumb.

As a result of conducting K-means clustering to determine the inherent meanings of keywords extracted from the 'GYO' tag network, 7 clusters such as 'gyo (growyourown)', 'garden and gardening', 'urban gardening', 'kitchen garden', 'sustainability', 'allotment', and 'etc.' were found (Table 2).

The first cluster is a combination of words that diversely refer to 'grow your own' such as 'yourown' and 'grow, growing'. The second cluster is on activities or items related to growing plants such as seed, harvest, and nodding. The third cluster is related to garden and gardening such as garden, gardeningwithkids, and gardeningformentalhealth. The fourth cluster is related to allotment in which local community residents participate voluntarily to freely grow plants in a common activity space. The fifth cluster is about kitchen gardens where families can grow their own food for self-sufficiency such as vegetablepatch and potager. The sixth cluster is related to sustainability such as permaculture, sustainablesprout, and sustainableliving. The seventh and last cluster represents urban gardening and related activities such as homestead, raisedbeds, and containergardening.

Centrality analysis of related keywords

To analyze the relational characteristics of 118 related words extracted based on 6,388 posts crawled and purified with hashtags 'gyo' and 'growyourown' as keywords on Instagram, we conducted social network analysis and centrality analysis

Table 2. Clustering with frequency of related word analysis in K-means

Cluster	Related words (frequency)	Division
1	gyo (5,936), growyourown (3,183), homegrown (1,489), growyourownfood (1,904), growwhatyoueat (941), eatwhatyougrow (821), growfood (308), homegrownfood (239), growyourownveggies (236), growingfood (190), growyourownveg (188), grow (188), growsomethinggreen (157), growingvegetables (137), growyourfood (130), growing (122), everyonecangrowtheirown (110), organicgrowing (102)	GYO (growyourown)
2	organic (878), flower (727), nature (403), greenhouse (397), nodig (393), seedlings (368), seeds (325), spring (102), grownfromseed (258), moestuin (218), horticulture (185), polytunnel (123), instagood (115), seedstarting (113), fruit (110), love (107), tomatotuesday (105), harvest (104), tomatoes (100), peppers (99), plants (96)	Etc.
3	gardening (1,951), gardens (1,338), organicgardening (1,063), gardensofinstagram (719), gardenlife (771), gardener (634), mygarden (494), greenthumb (433), instagarden (319), thehappygardeninglife (313), happygardener (313), greenfingers (310), organicgarden (278), girlswhogarden (260), gardenersofinstagram (258), gardenlove (238), gardeninglife (225), inmygarden (212), instagardeners (204), gardeninspiration (181), gardenersworld (175), gardeningformentalhealth (173), plantsofinstagram (167), homegarden (166), gardeningtips (135), gardeninguk (135), gardenblogger (131), gardeningaustralia (127), mygardentoday (112), beginnergardener (108), cottagegarden (107), gardeningwithkids (106)	Garden and gardening
4	allotment (2,611), allotmentlife (1,783), allotmentuk (1,232), allotmentlove (1,047), allotmentgarden (998), allotmentsofinstagram (786), allotmentshed (150), allotmenteer (108), allotmentgardening (101)	Allotment
5	kitchengarden (1,593), vegetablegarden (1287), ediblegarden (1096), vegpatch (794), veggiegarden (714), vegetables (666), potager (286), veggiepatch (270), veggies (251), homegrownveggies (189), veg (169), vegetablegardening (154), growvegetables (137), vegetablepatch (134), veggarden (130), herbs (112)	Kitchen garden
6	sustainableliving (355), permaculture (265), thegoodlife (211), selfsufficient (130), sustainablesprout (130), sustainable (127)	Sustainability
7	urbangarden (555), backyardgarden (330), raisedbeds (313), growfoodnotlawns (302), mymonthontheplot (296), urbangardening (286), vegplot (246), gardentotable (235), containergardening (161), homestead (140), backyardgardening (130), plot (127), nodiggarden (125), urbanorganicgardenr (102), raisedbedgardening (100), vegplotgarden (100)	Urban gardening

to verify degree centrality, betweenness centrality, eigenvector centrality, and closeness centrality. The results provided the top 30 (Table 3) and visualized network analysis up to the top 50 (Fig. 2).

For degree centrality of keywords related to 'gyo', gyo and growyourown showed the highest degree centrality at 1.0, followed by allotment and gardeninglife 0.98, raisedbeds and growyourownveggies 0.95, eatwhatyougrow, garden, and sustainable 0.93, and growyourownfood and gardensofinstar-

gram 0.90. As such, words with high degree centrality are located near 'gyo' and directly networking with other related words (Fig. 2). Words in various combinations that represent GYO such as growyourownveggies, growyourownfood, and eatwhatyougrow show the online user participation and interest in GYO and even encourage users to actually participate through urban gardening such as allotment and raisedbed.

Closeness centrality was highest for gyo at 0.66, followed by growyourown 0.52, seeds 0.41, growyourownfood, rai-

Table 3. Social network analysis of top 30 related words

Degree centrality		Closeness centrality		Betweenness centrality		Eigenvector centrality	
Hashtags	Coef[z]	Hashtags	Coef	Hashtags	Coef	Hashtags	Coef
GYO	1.00	GYO	0.66	GYO	0.12	Allotment	0.94
Growyourown	1.00	Growyourown	0.52	Growyourown	0.10	Growyourown	0.93
Allotment	0.98	Seeds	0.41	Gardeninglife	0.07	GYO	0.92
Gardeninglife	0.98	Growyourownfood	0.40	Allotment	0.07	Gardeninglife	0.88
Raisedbeds	0.95	Raisedbeds	0.40	Growyourownfood	0.05	Growyourownveggies	0.63
Growyourownveggies	0.95	Spring	0.40	Raisedbeds	0.04	Eatwhatyougrow	0.59
Eatwhatyougrow	0.93	Veggarden	0.40	Growyourownveggies	0.04	Raisedbeds	0.56
Garden	0.93	Kitchengarden	0.40	Eatwhatyougrow	0.03	Growyourownfood	0.49
Sustainable	0.93	Sustainable	0.35	Seeds	0.01	Organic	0.38
Growyourownfood	0.90	Grow	0.34	Seedlings	0.01	Gardening	0.35
Gardensofinstagram	0.90	Growvegetables	0.34	Allotmentlife	0.01	Gardensofinstagram	0.32
Gardening	0.88	Herbs	0.34	Allotmentuk	0.01	Seeds	0.30
Organic	0.88	Homegrown	0.34	Gardensofinstagram	0.01	Seedlings	0.30
Greenhouse	0.88	Gardeninglife	0.34	Gardening	0.01	Allotmentlife	0.30
Spring	0.88	Gardeningtips	0.34	Organic	0.01	Allotmentuk	0.30
Herbs	0.87	Allotment	0.32	Harvest	0.01	Harvest	0.27
Growvegetables	0.87	Greenhouse	0.29	Thegoodlife	0.01	Thegoodlife	0.27
Polytunnel	0.87	Growingvegetables	0.29	Greenhouse	0.01	Greenhouse	0.27
Grownfromseed	0.85	Polytunnel	0.29	Polytunnel	0.01	Polytunnel	0.27
Homegrown	0.85	Growingfood	0.29	Growyourfood	0.01	Growyourfood	0.27
Potager	0.83	Growyourownveggies	0.29	Spring	0.01	Spring	0.27
Seeds	0.83	Horticulture	0.29	Gardeningtips	0.01	Veggarden	0.27
Tomatotuesday	0.83	Plants	0.29	Veggarden	0.01	Gardeningtips	0.27
Grow	0.83	Potager	0.29	Garden	0.01	Garden	0.27
Mymonthontheplot	0.82	Garden	0.28	Sustainable	0.01	Sustainable	0.27
Allotmentlife	0.80	Seedlings	0.26	Allotmenteer	0.01	Allotmenteer	0.27
Harvest	0.80	Eatwhatyougrow	0.26	Cottagegarden	0.01	Cottagegarden	0.27
Girlswhogarden	0.80	Ediblegarden	0.26	Veggies	0.01	Veggies	0.27
Kitchengarden	0.79	Gardensofinstagram	0.26	Greenfingers	0.01	Greenfingers	0.27
Gardeningtips	0.78	Growfood	0.25	Potager	0.01	Potager	0.27

[z]Coef: coefficient.

Fig. 2. Top 50 related words visualization of social network analysis.

sedbed, spring, veggarden, and kitchengarden 0.40, sustainable 0.35, and grow 0.34. Closeness centrality is measured by considering even indirect connections unlike degree centrality (Choi and Gim, 2015), and thus even related words with high closeness centrality may not be located at the center of the network and yet have strong independent influence. As such, even though related words with relatively high closeness centrality such as spring and grow are not at the center of the network, they have a noticeable influence on each node. Moreover, considering that items, seasons, and tips related to plant growing such as seeds, spring, herbs, and gardeningtips have high closeness centrality, GYO participants actively share contents and tags about their life as a gardener such as their crops and gardening tips.

Next, gyo showed the highest betweenness centrality at 0.12, followed by growyourown 0.10, gardeninglife and allotment 0.07, growyourownfood 0.05, raisedbed and growyourownveggies 0.04, and eatwhatyougrow 0.03, showing relatively lower centrality compared to degree and closeness centrality. Betweenness centrality is a calculation of centrality between words and thus best captures the words with high influence (Lee and Kim, 2018), and it is related to the mediating or regulating role of the entire network (Heo and Yun, 2020). However, as a result of the betweenness centrality analysis in this study, there

are no related words with remarkably high centrality, thereby proving that there are no related words that have a great effect on the network as a key link that connects other nodes.

Allotment showed the highest eigenvector centrality at 0.94, followed by growyourown 0.93, gyo 0.92, gardeninglife 0.88, growyourownveggies 0.63, eatwhatyougrow 0.59, raisedbed 0.56, growyourownfood 0.49, and organic 0.38. Eigenvector centrality (also referred to as eigencentrality) is a useful measure in finding the most influential central nodes within the network (Kim, 2017). One thing to note is that all of degree centrality, closeness centrality, and betweenness centrality were high in gyo and growyourown, whereas the related word with highest eigenvector centrality was allotment. This indicates that allotment is a related word with high connectivity to GYO and thus has a great influence. Organic and gardening that belong to the top 10 can also be interpreted in the same context. Nodes connected in a network show that GYO participants display their identity in a sustainable life by being self-sufficient and growing their own organic food through urban gardening like allotment.

Conclusion

This study is conducted to establish strategies to encourage and maintain home gardening activities and identify the trend and relationship structure through social network centrality analysis and related word analysis on 'GYO' by analyzing the big data of hashtags #gyo and #growyourown collected on Instagram. For social network analysis, we collected 6,388 posts including keyword hashtags (#gyo, #growyourown) from June 13, 2020 to April 13, 2021, extracted 118 related keywords through Word2Vec, and identified 7 clusters with K-means clustering. Moreover, we conducted social network analysis to determine the centrality of related words and visualized the results using Gephi 0.9.2 (Fig. 2).

As a result of conducting K-means clustering to group 118 related words with those that have highest similarity, 7 clusters such as 'gyo (growyourown)', 'garden and gardening', 'urban gardening', 'kitchen garden', 'sustainability', 'allotment', and 'etc.' were found. The first cluster 'gyo' represents a combination of words that indicate 'grow your own' such as growyourown, homegrown, growwhatyoueat, and growsomethinggreen. The second cluster 'etc.' is on activities or items related to growing plants such as seed, harvest, and nodding. The third cluster is related to 'garden and gardening' such as garden, gardening, gardeningwithkids, happygardener, and gardeningformentalhealth, showing that various forms of gardening activities are carried out. The fourth cluster 'allotment' includes words such as allotmentlife and allotmenteer, showing that GYO is carried out by participating in allotment, which is one of the systems to rent out land to individuals (Allotments Act 1922) so that individuals can grow their own agricultural products including vegetables. The fifth cluster is about 'kitchen garden' where families can grow their own food for self-sufficiency such as ediblegarden, vegetablepatch, and potager. The sixth cluster 'sustainability' includes words such as permaculture, sustainablesprout, and sustainableliving, showing that participants are expressing their identity and interest in sustainable agriculture and gardening as an alternative to urban environmental problems through GYO. The last cluster, 'urban gardening', incudes words such as homestead, raisedbeds, and containergardening and shows how users participate in urban gardening and related activities such as GYO.

As a result of social network centrality analysis, degree centrality was highest in gyo and growyourown, followed by allotment, gardeninglife, raisedbeds, growyourownveggies, eatwgatyougrow, and sustainable. This showed that various combinations of words meaning 'gyo' (growyourownfood, growyourownveggies, growwhatyoueat, etc.) represent users' participation and interest and encourage their activities online. Related words with high closeness centrality such as gardeningtips, seeds, seedlings, spring, herbs, and harvest were used in sharing everyday life related to growing plants such as seasons, tips, and items. Words such as greenfingers, thegoodlife, gardeninglife, and gardensofinstagram were used to express positive emotions and pride in gardening activities as a gardener. The related word with highest eigenvector centrality was allotment, showing high connectivity and influence with gyo and growyourown that indicate 'GYO' itself. In sum, users are participating in urban gardening such as 'GYO' with positive emotions and pride through allotment, raisedbeds, and kitchengarden and are aiming for self-sufficient and sustainable life by growing their own organic food.

In particular, considering that many participants are encountering urban gardening through 'allotment', the social trend is reflecting the importance of urban gardening due to increased interest and benefits of urban agriculture such as healthy food production, sustainable urban development, sound activities for all ages, encouragement of harmony, preservation of biodiversity, and fulfillment of needs to heal through nature in the city (Yoon, 2016).

As the constraints on social activities are continued due to the COVID-19 pandemic and mental stress is increasing with the fear of infection and skepticism over monotonous routines, 'home' is perceived as the safest place and hub for well-being to do anything. In this atmosphere, home gardening is encouraged as an activity to promote emotional stability and adequate physical activities or change the indoor atmosphere. In fact, the relevant market is growing, and participants are also constantly increasing (Corley et al., 2021; KOTRA, 2020). The home gardening trend is diffused as the value of health as well as physical and mental healing has become more important in the age of turmoil. Considering this fact, having identified the online trend in urban gardening through 'GYO', this study will

have utility value as the data for establishing urban gardening plans considering the emotions and identity of participants as well as their dispositions.

However, this study has the following limitations. First, there are limitations in generalizing the trend and relationship structure since data were collected only on Instagram among social media. Research must be conducted on social media with many users of all ages worldwide such as Facebook and Twitter. Second, only English hashtags were collected for keywords. To identify the trend in Korea, it is necessary to collect and empirically analyze Korean hashtags. Third, to more closely identify the trend, it is necessary to comparatively analyze the overall trend of urban gardening such as GYO before and after COVID-19. To this end, research must be conducted on selecting the scope of data collection and finding detailed methods to extract data.

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