



Research Article

# Complementary and Alternative Medicine (CAM): Single, Multiple and High-Density Function Locations in Intermediately Sized Centers in Ontario, Canada

Stephen P Meyer\*

School of Northern and Community Studies-Geography Unit, Laurentian University, Ontario, Canada

## Abstract

Research on the geography of Complementary and Alternative Medicine (CAM) is emerging; yet, assessing function at CAM locations remains novel. This paper uses nearest neighbor analysis, closest facilities analysis and point density tools, within the Geographic Information Systems (GIS) environment, to compare the geographies of single, multiple and high-density function locations in 14 intermediately sized centers in the Canadian province of Ontario. Based on a sample of 2,326 CAM functions, 72.9% are concentrated in space and are situated: inside the same neighborhood, at the same address and/or 'within' the same CAM provider. Deductively, these clustering benefits, or agglomeration economies, accrue to both CAM practitioners and CAM patients. There is deviation by region, as northern residents travel further to CAM function (more than 6.3 kilometers) compared to those in the south (typically less than 4.0 kilometers). Spatial properties by CAM type show distinctiveness with massage therapy functions more likely to be outside, and naturopathic services within, CAM function concentrations and chiropractic, acupuncture and homeopathic functions intermediate by comparison.

**Keywords:** Agglomeration economies; Complementary and Alternative Medicine (CAM); Geographic Information Systems (GIS); Spatial analysis

## Introduction

Complementary and Alternative Medicine (CAM) and its inherent holistic approach to health care, has many forms including: massage, chiropractic, acupuncture, naturopathic, homeopathic and so on. Those interested in CAM are probably most familiar with articles

**\*Corresponding author:** Stephen P Meyer, School of Northern and Community Studies-Geography Unit, Laurentian University, Ramsey Lake Road, Greater Sudbury, ON P3E 2C6, Canada, Tel: +1 7056751151; Extn: 3431; E-mail: smeyer@laurentian.ca

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(both academic and otherwise) that are not particularly geographical in context. Common areas of focus include highlighting CAM procedures and/or evaluating the effectiveness of CAM approaches. Contributions to the CAM literature that are parenthetically geographical in scope are accumulating; and often these studies profile CAM users in specific places and/or evaluate CAM's position within wider health care systems and its potential to integrate with Conventional Medicine (CM) facilities in particular cities or rural areas. An important subset of the literature is also emerging comprised of studies that utilize datasets that contain actual (or an aggregation of) CAM location points. Such analysis provides for a far more direct spatial assessment of CAM resources over space.

Wardle et al., mapped geocoded points of homeopaths, naturopaths, chiropractors, acupuncturists and osteopaths in rural South-west Wales, Australia and found that CAM practitioners are prevalent in all rural areas whether well served or under served by CM providers [1]. Egan et al., reported that the distribution of CAM units available for people with cancer in England, Scotland, Wales and Northern Ireland are uneven amongst and within these countries [2]. Most of these units are within the hospital grounds and counseling is the most common CAM treatment. Other studies use location based data for regression analysis in: the Netherlands to predict alternative medical use by settlement characteristics, patient traits and perceptions towards CAM and CM; the United States to show that overall health professional shortage areas are related to chiropractic practice volume; and Arizona and Washington to establish relationships between the number of naturopaths per county and proximity to naturopathic medical school and population density [3-5]. Using both regression and spatial autocorrelation cluster analysis, Sanders et al., assessed clinic locations for health care providers offering musculoskeletal therapies (physiotherapy, chiropractic, acupuncture and the like) and general practitioners in Auckland, New Zealand [6]. They determined that privately funded offices cluster in central areas whereas publically funded clinics disperse more evenly across the study area. In Auckland, clinic location appears to be correlated with proximity to major roads and urban centers, socio economic status and ethnicity. There is evidence that CAM office frequency is higher in regions of the Republic of Ireland where religious affiliation is less prevalent [7]. By also emphasizing location data, Williams showed that the spatial pattern of CAM offices behaves in a contagious and hierarchical manner with diffusion from larger urban areas in British Columbia and Ontario [8]. Through spatial autocorrelation analysis and, like Williams, with a methodology steeped in diffusion theory, Albert and Butar found that the licensing of naturopathic medicine occurs in a contagious fashion in the United States and Canada and therefore spatial proximity is important in predicting where new licenses will materialize (at the state and province level, respectively) [9]. Albert reiterated that ND certification spreads in a contagious fashion, from licensed states to adjacent or proximal non-licensed states, and highlight New York and Colorado as key areas for continued diffusion in the United States once NDs become licensed in these jurisdictions [10].

Meyer has published several papers utilizing the actual addresses of CAM location points to assess a variety of geographic trends for Ontario municipalities throughout the province and/or for regions

within Ontario cities. Some of the highlights include the following. General nearest neighbor and nearest neighbor hierarchical clustering procedures show that CAM offices significantly cluster within four intermediate sized cities [11]. CAM displays a more even pattern across the urban rural continuum in Ontario in comparison to CM offices and certain CAM and CM specializing municipalities are associated with community well being indicators and urban density measures [12]. With the use of spatial autocorrelation analysis, location quotients and standard distance calculations, it is shown that acupuncture offices create a unique and highly polarized pattern in comparison to CAM in general and CM offices in the Toronto metropolitan area. These acupuncture office clusters occur primarily in neighborhoods with high proportions of people with Chinese and Southeast Asian ethnic origins [13]. Larger urban areas generally exhibit superior levels of spatial accessibility to both CAM and CM compared to more peripheral/rural areas, but in many areas of the province the difference is not striking and this challenges the often assumed 'urban rich, rural poor' assessment of health care resources common to studies that consider only access to CM [14]. Regression analysis results show the association between place specific criteria, such as urbanization, diverse markets and closeness to other CAM operations, with various types of CAM office frequency (chiropractic, massage, holistic, acupuncture, naturopathic and homeopathic) [15]. The spatial distributions of acupuncture treatment locations throughout metropolitan Toronto were categorized in terms of visibility characteristics (as measured by proximity to main roads and commercial land use) and advertising tendencies (as estimated by advertising budgets and the size of yellow page ads). Many of these offices are situated in high visibility/high volume areas and pursue aggressive advertising approaches to attract patrons. In contrast, other offices depend on an impeccable reputation, locate in low visibility areas, and pursue a more modest approach to advertising [16]. By analyzing office location data and survey information, evidence of an interesting paradox emerges; collectively many Naturopaths (NDs) locate in or near visible sites even though the majority of their patients would seek their expertise regardless of where they locate. Most patients of NDs indicate they put far more weight on quality of service than on spatial accessibility [17]. Spatial autocorrelation and nearest neighbor analyses reveal that most naturopaths are indeed proximate to significant clusters of Doctors of Medicine (MDs), however survey data show that while greater integration with the CM sector is welcomed (by naturopaths and their patients), this is not occurring to any great degree in practice. Spatial proximity between NDs and MDs may provide the opportunity for deeper integration in delivering patient care, but significant barriers persist largely due to the perception that many MDs lack respect for and/or knowledge of naturopathic approaches [18].

This study adds to the 'geography of CAM' literature, but it does so by going beyond assessing just CAM location and evaluates the spatial properties of CAM function at specific location points within fourteen Ontario cities.

## Materials and Methods

A sample of 2,326 CAM functions was compiled that contain registered massage therapy (which in some cases include osteopathy), chiropractic, acupuncture (which may also include other forms of Traditional Chinese Medicine), naturopathic medicine and homeopathy. These five classes of function were collected specifically for 14 Census Metropolitan Areas (CMAs) of over 100,000 or Census Agglomerations (CAs) 50,000 to 100,000 in Ontario [19]. These locations

are Barrie, Belleville, Greater Sudbury, Kingston, Kitchener Waterloo Cambridge, London, North Bay, Oshawa, Peterborough, Sarnia, Sault Ste. Marie, St. Catharines Niagara, Thunder Bay and Windsor. Given the exclusion of the province's three most populated metropolitan areas (Toronto, Ottawa and Hamilton) and that CAs attain at least 50,000 in population, these 14 CMAs/CAs represent a subset of intermediately sized centers in Ontario [20]. For spatial diversity, CMAs/CAs from the eastern, central, western and northern parts of the province was chosen (Figure 1).

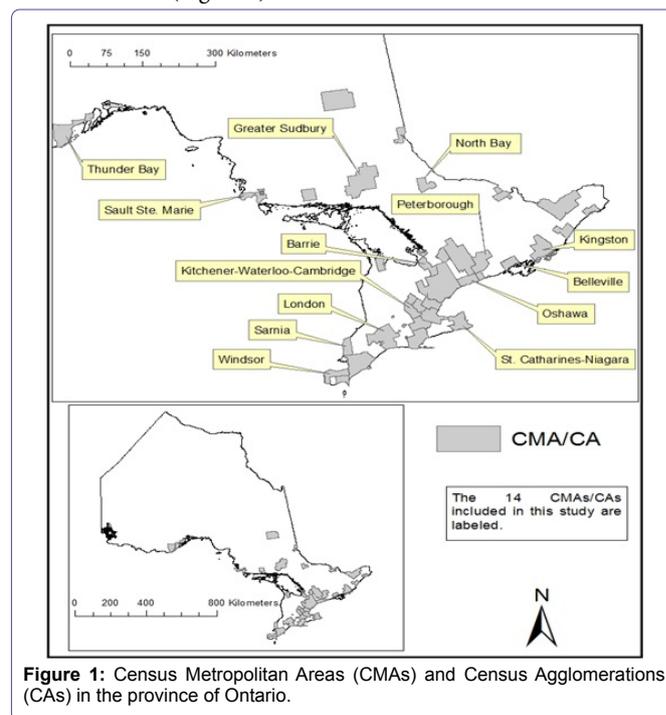


Figure 1: Census Metropolitan Areas (CMAs) and Census Agglomerations (CAs) in the province of Ontario.

The address of each CAM function was recorded into a unique dataset. Two key data sources were used to build this database: Info Canada [21] and Yellow Pages Canada [22]. Info Canada uses telephone directories, annual reports and various governmental records to compile information and the company telephone verifies each case [21]. Additional CAM functions not listed by Info Canada were retrieved through the Yellow Pages Canada website (during May and June of 2014). The cartographic boundary files (CMAs/CAs and provincial boundaries) and road network files were downloaded from the Statistics Canada website [23,24]. The address locator tool in ESRI's Geographic Information Systems (GIS) software ArcGIS was used to geocode the CAM function addresses as points on to the road network layer [25].

## There are four main objectives of this study:

1. To assess and compare the spatial properties of CAM locations in terms of single function, multifunction and high-density cluster function.
2. To measure distances from points of demand to nearest single, multiple and high-density function locations.
3. To compare CAM function type (massage, chiropractic, acupuncture, naturopathic and homeopathic) in relation to single, multiple and high-density function locations.
4. To discuss these findings in terms of agglomeration economies implications. Three key procedures carried out with ArcGIS helped satisfy the first three objectives: nearest neighbor analysis, a point density procedure and closest facilities analysis.

The Nearest Neighbor Ratio (NNR) indicates if an observed pattern of points deviates from a theoretical (expected) random distribution sufficiently enough to be deemed significantly clustered or dispersed [26]. NNRs range from 0 (completely clustered) to greater than 2 (extreme dispersion). NNRs were computed and compared for CAM functions and CAM locations within the aforementioned 14 centers. This procedure allowed for CAM function locations to be objectively compared in terms of clustering, dispersion and/or random pattern propensities.

CAM function density surfaces identify where high concentrations of CAM services occur within each CMA/CA. The point density tool created density raster layers from the CAM function points. Each raster cell contains CAM functions per square kilometer. Five classes were identified with the natural breaks (Jenks) method of classification. The top two density class intervals were isolated (with the re-classify tool) and displayed as High-Density CAM Function Clusters (HDCFCs). Each HDCFC was converted from raster to vector polygons. Figure 2 provides an illustration of the HDCFC polygons for the Greater Sudbury CMA. The derived HDCFCs contain both single and multiple function office locations and indicate 'neighborhoods' where CAM function is comparatively abundant.

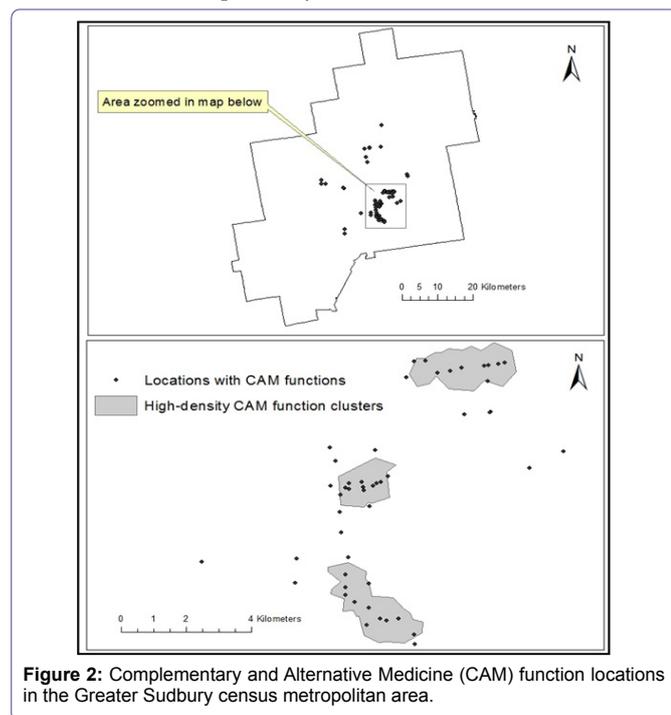


Figure 2: Complementary and Alternative Medicine (CAM) function locations in the Greater Sudbury census metropolitan area.

The ArcGIS network analyst extension measures the mean distance travelled from demand points to various locations of CAM function. An understanding of the distances between demand points and CAM function provides information on patient/customer accessibility to CAM supply. The mean distance travelled from 100 randomly selected points, in each of the 14 aforementioned centers, was measured to closest CAM functions. These demand points mimic household and/or workplace locations. The random selection of these demand points was as follows. In each CMA/CA, 100 road segments were randomly selected with the IBM SPSS Statistics [27] software. The road network is made up of road segments that are joined at intersections. Since there are many more intersections, and thus road segments, where there are more people and/or economic activity, the random sample is inherently weighted by population density. Then, the 'create random

point' tool randomly placed a point on each of the 100 selected road segments in each of the 14 CMAs.

Agglomeration economies, whether localization or urbanization, are benefits that firms or organizations achieve by being close in space. Localization economies accrue to similar firms doing similar things in close proximity and urbanization economies are advantages firms of any type gain by being in urban, particularly metropolitan, high-density areas. In the context of CAM, localization advantages can manifest to the CAM professional and/or patient by: reducing costs through sharing office resources and staff with colleagues, being proximate to specialized tacit knowledge, and offering patients the ability to choose from a range of CAM functions in one convenient location. CAM operators offering services in high volume, central and highly visible locations (urbanization advantages) may benefit from increased sales in comparison to CAM operators in more peripheral locales. Spatial proximity of CAM function can occur: within the same HDCFC (with many CAM functions available within walking distances), within the same office setting (in which a chiropractor, massage therapist and a naturopath coexist, for instance) or 'within the same professional' (a CAM provider skilled in homeopathy, naturopathy and acupuncture, for example). The observed patterns of CAM function in light of agglomeration economies implications are presented in the discussion section.

## Observations

### CAM by function in 14 cities

Table 1 shows that the number of CAM locations (addresses that contain at least one CAM function) and CAM functions generally increase with CMA/CA population size. Yet, when population standardizes CAM function, some variations occur. For instance, the three cities with the highest CAM functions per capita are Peterborough (11.12 CAM functions per 1000 people) Thunder Bay (10.77) and North Bay (9.99); the former two being comparatively small CMAs (in the 120,000 population range) and North Bay is a CA (at roughly 64,000). Conversely, the two lowest CAM functions per capita estimates are attained in Oshawa (5.64) and London (6.09); even though both of these CMAs rank within the top four most populated metropolitan areas in this study (and within the top seven in Ontario proper). Thus, center size does not necessary translate into more CAM functions per capita.

Of the total 1,365 CAM locations within these 14 cities, 843 (or 61.8%) are single function locations, leaving 522 (38.2%) locations that feature more than one CAM function. While the 'two function' scenario is the most common multifunction construct, there are 24 locations in which six or more CAM functions are available at the same address; table 2. The vast majority of these multifunction locations feature varying degrees of diversity in the type of services delivered and this is achieved in one of two ways. Either there are different types of CAM providers at a location (a naturopath and a chiropractor at the same address, for instance) or the same practitioner is offering more than one CAM function (a naturopath who also gives chiropractor adjustments, for example). While diversity in function is typical of multifunction locations, considerable overlap in the same, function is also evident in a slight majority of cases (56.5%). There are 141 locations in which all of the functions are homogenous (three massage therapist at a single location, for example) and an additional 154 multifunction locations that feature varying degrees of overlap with some diversity (three chiropractic options, along with massage and homeopathic services, for instance).

Census Metropolitan Area (CMA) and Census Agglomeration (CA)	Population 2011 <sup>a</sup>	Number of CAM locations	Number of CAM functions	CAM functions per 10,000 people
Barrie (CMA)	187,013	100	174	9.3
Belleville (CA)	92,540	31	63	6.81
Greater Sudbury (CMA)	160,770	69	118	7.34
Kingston (CMA)	159,561	69	104	6.52
Kitchener-Waterloo-Cambridge (CMA)	477,160	244	375	7.86
London (CMA)	474,786	180	289	6.09
North Bay (CA)	64,043	37	64	9.99
Oshawa (CMA)	356,177	120	201	5.64
Peterborough (CMA)	118,975	76	133	11.12
Sarnia (CA)	89,555	43	77	8.6
Sault Ste. Marie (CA)	79,800	32	53	6.64
St. Catharines-Niagara (CMA)	392,184	181	310	7.9
Thunder Bay (CMA)	121,596	58	131	10.77
Windsor (CMA)	319,246	125	234	7.33
Total above	3,093,406	1,365	2,326	7.52

**Table 1:** Complementary and Alternative Medicine (CAM) locations and functions, population and primary core.

Number of functions at a location	Characteristics
Two functions (295 locations)	Two functions the same - 113 (38.3%) Two functions different - 182 (61.7%)
Three functions (125 locations)	Three functions the same - 25 (20.0%) Two functions the same, one different - 59 (47.2%) Three functions different - 41 (32.8%)
Four functions (50 locations)	Four functions the same - 1 (2.0%) Three functions the same, one different - 16 (32.0%) Two pairs the same - 14 (28.0%) Two the same, two distinct - 15 (30.0%) Four different - 4 (8.0%)
Five functions (28 locations)	Five functions the same - 2 (7.1%) Four functions the same, one different - 4 (14.3%) Three the same, two the same - 5 (17.9%) Three the same, the rest different - 4 (14.3%) Two pair the same, one different - 10 (35.7%) Two the same, the rest different - 3 (10.7%)
Six functions or more (24 locations)	More than five functions the same - 7 (29.2%) Three or four functions the same - 16 (66.7%) Two pair the same, two distinct - 1 (4.1%)

**Table 2:** Homogeneous and/or diverse functions in multifunction locations.

The geographic properties inherent to CAM function and location are compared directly by considering the nearest neighbor ratios and associated levels of statistical significance. As shown on table 3, CAM function has an unambiguous tendency to cluster in space; in all 14 cities, NNRs are statistically significant within this regard. Even though Sarnia, Kingston and Belleville post the highest NNR values for CAM function, these are still low enough to be deemed significantly clustered with 99% statistical certainty. At the other end of the spectrum, CAM function in Barrie, Windsor and Greater Sudbury are extremely concentrated in space (with NNRs of 0.24 and less). The clustering tendencies of CAM location is not quite as clear as function, but nine of the 14 cities still achieve statistical significance. When the nearest neighbor analysis was run distinctly for single and multifunction locations, the results began to diverge. While all 14 centers attain statistical significance for single function locations, there is a mix of clustered and dispersed patterns. Interestingly, the five centers that display significantly dispersed single function locations are CAs (Belleville, Sarnia and Sault Ste. Marie) and a smaller CMA (Thunder

Bay). Nevertheless, the majority of cases (nine cities) exhibit clustered patterns and this is largely in keeping with the 'all CAM locations' scenario mentioned above. On the other hand, only two of the 14 centers feature clustered patterns for multifunction CAM locations as most of the NNRs are random (statistically insignificant). This outcome is logical. Multifunction locations are already clustered internally; with anywhere from two to 17 functions at the same address. Thus, the fact that the multifunction locations display a less clustered pattern over space in most of these cities is analogous to larger shopping agglomerations (containing many functions) rarely being geographically proximate.

The High-Density CAM Function Clusters (HDCFCs) are comprised of CAM functions that are comparatively close in space. In the case of all 14 CMAs/CAs, the HDCFCs are located within downtown/core areas and/or in locales just adjacent to the downtown. The number of CAM functions within these HDCFCs varies by the 14 CMAs/CAs, as shown in the second column on table 4. While the 14 city norm is 36%, this proportion divergences from over half in three cities

Census Metropolitan Area (CMA) and Census Agglomeration (CA)	NNRs for CAM functions	NNRs for CAM locations	NNRs for single function CAM locations	NNRs for multifunction CAM locations
Barrie (CMA)	0.18	0.67	0.73	0.8
Belleville (CA)	0.46	1.13 <sup>c</sup>	1.56 <sup>b</sup>	0.90 <sup>c</sup>
Greater Sudbury (CMA)	0.24	0.46	0.53	0.83 <sup>c</sup>
Kingston (CMA)	0.5	0.79	1.05	1.08 <sup>c</sup>
Kitchener-Waterloo-Cambridge (CMA)	0.39	0.7	0.69	0.93 <sup>c</sup>
London (CMA)	0.24	0.54	0.67	0.59
North Bay (CA)	0.29	1.14 <sup>c</sup>	1.16	1.87 <sup>b</sup>
Oshawa (CMA)	0.4	0.84	0.84	0.97 <sup>c</sup>
Peterborough (CMA)	0.28	0.54	0.66	0.92 <sup>c</sup>
Sarnia (CA)	0.53	0.98 <sup>c</sup>	1.33 <sup>b</sup>	0.97 <sup>c</sup>
Sault Ste. Marie (CA)	0.43	0.91 <sup>c</sup>	1.55 <sup>b</sup>	1.09 <sup>c</sup>
St. Catharines-Niagara (CMA)	0.28	0.55	0.56	0.7
Thunder Bay (CMA)	0.38	1.00 <sup>c</sup>	1.29 <sup>b</sup>	1.20 <sup>c</sup>
Windsor (CMA)	0.2	0.52	0.51	0.83

**Table 3:** Nearest Neighbor Ratios (NNRs)<sup>a</sup>.

<sup>a</sup>All NNRs are significantly clustered at a confidence interval of at least 99%, unless otherwise indicated: <sup>b</sup>significantly dispersed at a confidence interval of at least 99% or <sup>c</sup>insignificant/random<sup>e</sup>.

Census Metropolitan Area (CMA) and Census Agglomeration (CA)	% of all CAM functions in HDCFCs	% of all CAM locations in HDCFCs	% of all CAM single function locations in HDCFCs	% of all CAM multifunction locations in HDCFCs
Barrie (CMA)	42.5	39	32.7	45.1
Belleville (CA)	33.3	25.8	17.5	35.7
Greater Sudbury (CMA)	50.8	44.9	39.5	53.8
Kingston (CMA)	29.8	24.6	20	33.3
Kitchener-Waterloo-Cambridge (CMA)	23.2	21.3	21.8	20.1
London (CMA)	36.3	33.3	29.2	40.3
North Bay (CA)	26.6	18.9	9.5	31.3
Oshawa (CMA)	30.3	26.7	25	29.5
Peterborough (CMA)	37.6	27.6	20.4	40.7
Sarnia (CA)	30	18.6	11.1	31.3
Sault Ste. Marie (CA)	67.9	46.8	42.1	76.9
St. Catharines-Niagara (CMA)	41.6	36.5	30.9	45.6
Thunder Bay (CMA)	53.4	36.2	25	46.7
Windsor (CMA)	29.1	24	17.4	32.1
Total above	36	30.3	25.1	38.4

**Table 4:** Complementary and Alternative Medicine (CAM) functions and locations in relation to High-Density CAM Function Clusters (HDCFCs)<sup>a</sup>: shown in percent.

<sup>a</sup>High-Density CAM Function Clusters (HDCFCs) are polygons with comparatively high densities of CAM function; as calculated with the ArcGIS point density tool.

in northern Ontario (Greater Sudbury, Sault Ste. Marie and Thunder Bay) to a low of 23.2% in Kitchener Waterloo Cambridge. Correspondingly, these three northern centers along with Barrie, London and St. Catharines Niagara are above the standard in terms of the number of CAM locations within HDCFCs. The final two columns on table 4 provide a notable contrast; in virtually all cases (except Kitchener Waterloo Cambridge), there are higher percentages of multifunction locations in HDCFCs in comparison to those posted for single function locations. In some cases, the proportions differ widely; such as with Belleville, North Bay, Peterborough, Sarnia, Sault Ste. Marie and Thunder Bay in which percentage are more than, or close to, double.

While both single and multifunction locations populate these zones of high-density CAM function, unsurprisingly the latter is more dominant. Since multifunction locations are by definition more dense than single function locations, it is predictable that the point density tool would frequently create HDCFCs in areas where multiple function locations gather in close proximity.

### Travelling to CAM functions

The average distances that people travel to their nearest CAM function reveal additional geographic properties. While correspondence is not perfect, there is evidence of a North-South divide. As shown on table 5, residents in the northern communities of Thunder

Census Metropolitan Area (CMA) and Census Agglomeration (CA)	Closest CAM location	Closest single function CAM location	Closest multifunction CAM location
Barrie (CMA)	4.7	5.9	5.3
Belleville (CA)	3.9	4.7	4.6
Greater Sudbury (CMA)	6.7	6.9	9.5
Kingston (CMA)	9.4	10.1	14.3
Kitchener-Waterloo-Cambridge (CMA)	1.5	1.7	2.3
London (CMA)	3.6	4.6	4.4
North Bay (CA)	6.3	8.4	6.8
Oshawa (CMA)	2.1	2.5	2.6
Peterborough (CMA)	6.9	7.3	9.6
Sarnia (CA)	4.8	5.1	5.8
Sault Ste. Marie (CA)	6.9	7.2	7.4
St. Catharines-Niagara (CMA)	2.3	2.6	3.4
Thunder Bay (CMA)	9	9.3	9.7
Windsor (CMA)	2.4	2.8	3.5

**Table 5:** Mean distance from demand points to Complementary and Alternative Medicine (CAM) single and multi-function locations: shown in average kilometers.

Bay, Sault Ste. Marie, Greater Sudbury and North Bay, along with the more southern Kingston and Peterborough communities, travel at least 6.3 kilometers to their closest CAM function. In contrast, people living in the other eight southern cities in this study travel less than 4.7 kilometers; and in some cases far less than that: Kitchener Waterloo Cambridge (1.5), Oshawa (2.1), St. Catharines Niagara (2.3) and Windsor (2.4). For the most part, distances to the closest single function and all multifunction sites combined are not that different and are usually only within a kilometer of deviation. Yet, in a few cases, the discrepancy is more notable, such as with Greater Sudbury and North Bay in the north (2.6 and 1.6 difference in kilometers, respectively) and Kingston and Peterborough in the south (4.2 and 2.3).

However, when disaggregating multifunction sites, patterns that are more flagrant emerge. Table 6 displays the average distance residents travel to CAM concentrations; whether that be locations that feature more than one CAM function or parts of the city that feature high densities of CAM options. Notice that the average kilometer values increase from the closest 'two function' CAM location, to the closest 'three or more function' CAM location to the closest HDCFC. This inclination unites almost all of the 14 CMAs/CAs, with Greater Sudbury and North Bay only slightly bucking this trend. Thus, the patterns on table 6 imply that the greater the CAM function concentration (in terms of services offered), the further most people need to travel to reach these CAM service areas. This notion is further corroborated when comparing tables 5 and 6. Single function locations are generally closer to most people than 'two functions' locations and deviance with single function locations increase in comparison to 'three or more functions' and HDCFCs sites.

### CAM function by type

The majority of CAM functions in these 14 cities are classified as massage therapy (which can include osteopathy) and chiropractic. As shown on table 7, these two CAM categories amass 1,862 (or roughly 80%) of the total 2,326 functions in this dataset. Acupuncture and naturopathic services are reasonably common, but not as abundant as massage and chiropractic services, and homeopathic functions are comparatively rare. Almost two-thirds of CAM functions are part of a multifunction location and situated outside of a HDCFC, but interesting deviation from these norms occurs by CAM type. Naturopathic,

acupuncture and particularly chiropractic functions are very common in multiple function locations, whereas homeopathic services are evenly split between single and multifunction sites. While a slight majority (55.1%) of massage functions occur in multifunction locations, this CAM category is also quite abundant in single function locations (with a 44.9% proportion that is well over the CAM average of 36.5%). Compared to the other CAM categories, naturopathic services display the highest propensity to be within a HDCFC; the proportion reaches virtual parity with those outside of HDCFCs (49.1 versus 50.9). At the other extreme, massage services locate most frequently outside of HDCFCs. The other three CAM types are intermediate, but all are above 60% in terms of functions outside of a HDCFC. Therefore, massage functions are the most likely form of CAM to be in single function locations and/or outside of HDCFCs. Conversely, naturopathic services are particularly attracted to concentrations of CAM activity, whether at the same location or within the same neighborhood. Chiropractic and acupuncture functions lean towards this 'naturopathic trend' although with proportions that are less outstanding, whereas homeopathic services are more akin to the massage pattern.

The typical distance that people travel to various CAM services in part substantiates the aforementioned tendencies, but the values presented on table 8 also relate to frequency of function. Massage and chiropractic services are most abundant over space and as a result present a greater chance for people to be close. Nevertheless, the fact that many massage services are located outside of concentrations and thereby are more dispersed throughout these 14 cities also gives residents a greater chance to be proximate. Naturopathic and homeopathic services occur with comparative rarity, making it more likely that people will travel further distances. Still, the fact that a relatively high proportion of naturopathic functions occur within HDCFC (which typically do not occur in great number throughout a CMA/CA) also contributes to higher travel distance.

### Discussion

The HDCFCs are located in the central locations of downtowns or areas adjacent to downtowns, in the 14 cities of this study, and the formation of these concentrations undoubtedly relates to agglomeration advantage. The centrality of these locations not only provides strong visibility via traffic volume, but also accessibility through main public

Census Metropolitan Area (CMA) and Census Agglomeration (CA)	Closest two function CAM location	Closest 'three or more function' CAM location	Closest HDCFC <sup>a</sup>
Barrie (CMA)	5.5	7.8	9.4
Belleville (CA)	5.6	4.9	12.4
Greater Sudbury (CMA)	12.1	10.1	15.2
Kingston (CMA)	14.4	15.3	15.7
Kitchener-Waterloo-Cambridge (CMA)	2.7	3.1	5.4
London (CMA)	4.8	5.9	8.8
North Bay (CA)	8.7	7.4	10.5
Oshawa (CMA)	3.7	3.9	8
Peterborough (CMA)	9.9	12.8	14.3
Sarnia (CA)	6.1	6.6	8.8
Sault Ste. Marie (CA)	7.8	8.6	7.4
St. Catharines-Niagara (CMA)	3.8	7.8	10.3
Thunder Bay (CMA)	10	10.2	10.6
Windsor (CMA)	3.9	5.9	6.9

**Table 6:** Mean distance from demand points to Complementary and Alternative Medicine (CAM) multifunction locations and to High-Density CAM Function Clusters (HDCFCs)<sup>a</sup>; shown in average kilometers.

<sup>a</sup>High-Density CAM Function Clusters (HDCFCs) are polygons with comparatively high densities of CAM function; as calculated with the ArcGIS point density tool. Distances are calculated from demand points to the centroid of the closest HDCFC polygon.

Function type and total number of functions	% of functions in single function location	% of functions in multifunction location	% of functions within HDCFC	% of functions outside HDCFC
Massage (1,032)	44.9	55.1	33.2	66.8
Chiropractor (830)	28.2	71.8	35.9	64.1
Acupuncture (259)	30.1	69.9	39.4	60.6
Naturopath (163)	31.9	68.1	49.1	50.9
Homeopath (42)	50	50	38.1	61.9
Total above (2,326)	36.5	63.5	36.1	63.9

**Table 7:** Complementary and Alternative Medicine (CAM) function by type: shown with respect to single and multifunction locations and High-Density CAM Function Clusters (HDCFCs)<sup>a</sup>.

<sup>a</sup>High-Density CAM Function Clusters (HDCFCs) are polygons with comparatively high densities of CAM function; as calculated with the ArcGIS point density tool.

Type	Median of closest function location	Median of closest single function location	Median of closest multifunction location
Massage	5.1	5.9	5.7
Chiropractor	5.4	7.6	6
Acupuncture	7.8	9.9	8.2
Naturopath	8.7	10.1	9.5
Homeopath	10.5	12.8	11.3

**Table 8:** Median distance from demand points to Complementary and Alternative Medicine (CAM) function by type: shown in average kilometers.

<sup>a</sup>Mean distances were calculated within 14 CMA or CA areas: Barrie, Belleville, Greater Sudbury, Kingston, Kitchener, London, North Bay, Oshawa, Peterborough, Sarnia, Sault Ste. Marie, St. Catharines-Niagara, Thunder Bay and Windsor. Then, median values were calculated from the mean distances of the 14 CMA/CA.

transit routes and other urbanization economies advantages. Localization economies are also strongly indicated. Whether populated by single or multiple function CAM locations, the richness of CAM services found in HDCFCs gives CAM patrons the ability to consult several CAM services within a 'neighborhood' in one trip and the ability for CAM professionals to make referrals to other colleagues within the same building or 'just down the block'. Localization advantage also accrues to CAM professionals who can meet 'face to face' with a nearby colleague to exchange knowledge. Hence, for many CAM operators, who are both health care providers and small business owners, the attraction of central, high volume areas and the ability to be 'seen' is no

different from what motivates other commercial proprietors to be in high visibility sites [16,17]. Moreover, the ability to exchange industry specific information with like-minded professionals in close proximity is a well-known explanation for high technology firm clusters and spatial closeness could in a similar way benefit CAM professionals with interest in exploring new medical therapies and procedures [28].

Those operating at locations offering multiple CAM functions within the same office/building also enjoy scale advantages; yet, the nature of these benefits may vary with the mix of CAM professionals on site. Three scenarios are possible. First, multiple CAM practitioners offering distinct services and choosing to share office space (or at least

be in the same building) means that localization advantages in particular must be occurring. Perhaps the CAM practitioners keep costs down by sharing administrative staff and medical equipment and enhance their expertise by gaining knowledge through collegial exchanges with professionals 'they see every day' [11,15]. Another consideration relates to the reality that most CAM patients pay for services 'out of pocket', since CAM is not covered by government health plans in Ontario and rarely completely included in employee health benefit packages [17]. As a result, patrons of CAM tend to be more affluent and in essence 'need be shared' by CAM providers. This leads to an important realization: if a goal is to maximize the revenues of an entire CAM office (and not just the individual health care providers within), then geographic proximity enhances the ability to share the pool of affluent clients. Referrals and recommendations to 'in-house' colleagues can be made and scheduling devised for synchronized consultation/treatment to maximize customer convenience and increase revenues of the office. A patient might be encouraged to receive a chiropractic adjustment directly after a naturopathic consultation, for example. Second, even in a situation with overlap in the same function, which occurs with some regularity in these 14 cities, direct CAM competitors (three massage therapists in the same building, for example) must still benefit from urbanization and/or localization economies. This would be like fast food establishments that routinely concentrate in space with direct competitors to benefit from urbanization economies advantages such as customer volume and visibility [29]. Of course, in terms of health care, three massage therapists at the same address might benefit from sharing office infrastructure as well. Third, if the multifunction location occurs exclusively because a single CAM professional delivers several CAM services, the scale advantages are largely internal to the CAM operator (and not just specifically external to an entire cluster of professionals), but still significant. Holding constant quality of care and reputation, CAM practitioners who render multiple functions may be more marketable and perhaps more profitable than those offering only one. For example, consider a chiropractor who also has proficiency in massage therapy and acupuncture. This CAM provider not only can attract new clients beyond those seeking chiropractic adjustments, but might also prolong an established client's treatment regime with a range of techniques to address a chronic or stubborn health concern.

There are two forms of single function CAM locations. The first involves practitioners within HDCFCs and, while not office sharing with other professionals or skilled in multiple CAM techniques, these practitioners are still proximate to many other CAM functions by being within an area of the city very dense in CAM service. Presumably, these CAM operators benefit from the aforementioned localization and urbanization advantages accruing in HDCFCs. The second category of single function CAM location is comprised of practitioners outside of HDCFCs and while this represents only 27.1% of all CAM function, this subset of CAM operators appear to be least affected by agglomeration advantage. Given the comparative proximity to potential patients, it is predictable that many of these practitioners practice throughout the city, perhaps from their place of residence. Cultivating a soothing environment in which to apply treatment is a goal of many CAM providers. Such a situation might be easier to achieve in an office/house setting situated more peripherally than in a busy part of downtown in a sterile building. Locating outside of HDCFCs in more outlying locations may also result in reduced rent costs, particularly if office space allocation is part of the residence. In addition, an efficacious and trustworthy reputation may offset the need for multiple functions and a central location that is more visible [17].

## Conclusion and Future Study

In conventional medicine, health teams are common and geography would appear to be biasing location decisions. Walk-in clinics typically have several MDs on site and medical centers often feature many doctors, specialists, pharmacies, lab facilities, medical technicians and other health care functions within one building or in very close proximity. The evidence from this research shows that similar trends occur with CAM function. Aside from a subset of single function CAM located outside of HDCFCs, most of the CAM functions (72.9%) cluster in space, which, by deduction, accrues various agglomeration economies advantages to patients and professionals. One might speculate that government bodies and the like design the majority of CM service concentrations in an apriority fashion; whereas CAM function clusters develop more organically and incrementally as certain CAM practitioners eventually discover the advantages of agglomeration economies. More research on the process of medical concentration formation would be instructive.

The principal finding of CAM concentration remains predominantly robust regionally and by type, but some important irregularities do occur. For instance, patients travelling to CAM function in northern communities cover greater distance than those in the southern part of the province. Moreover, naturopathic and massage functions are at opposite ends of the spectrum in terms of HDCFC membership and single function propensity. Subsequent study could assess travel distances to other consumer services, along with CAM function, and determine if 'north/south' differences are typical of commercial activity in general or CAM function specific. It would also be informative to more completely evaluate why there is a greater tendency for massage therapists to be 'lone wolfs' and for naturopaths to be more strongly inclined to offer their services in close proximity to other CAM functions. As with uncovering how medical concentrations in general evolve, supplementary research regarding the location motivations of naturopath, massage and other CAM function would benefit from interview/questionnaire based data and some form of qualitative analysis.

While the emphasis of this paper was on the geographic properties of CAM function and not on clinical efficacy, future research could consider potential relationships between space and CAM treatment outcomes. One might evaluate if the successful utilization of particular CAM procedures or remedies are consistent over space or if spatial bias occurs. While Meyer established that acupuncture offices are more abundant in parts of Toronto with a high proportion of Chinese and Southeast Asian residents, other spatial cultural aspects could be explored in terms of CAM effectiveness [28]. In addition, CAM efficacy and/or office location preferences could also be studied in light of income characteristics of neighborhoods within cities. Inevitably, when assessing CAM effectiveness, specialized datasets would need to be collected from a sample of CAM providers and CAM patients.

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