Regional Cattle Ketosis and Human CHD Explained by Similar Geographic Factors Associated with Weathering

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ABSTRACT

Objective: Weathering of silicates produces Ca and Mg cations and soluble silicon (Si. gw). Ketosis, Acetonaemia (Keto) is a metabolic disorder associated with intense adipose mobilization, high glucose needs and partial anorexia, typical in early lactation. The Keto data are based on veterinary reports from eight Decembers in 1979-93 [Keto.(79-93) (.Dec)] and from 3x12 months from 1994-96 [Keto.(94-96).(1/12)].This study is assessing geographic associations of Keto and (male) CHD (from 1964-84) with weathering related: groundwater (gw) hardness [(Ca+Mg).gw], [Si.gw], [(Mg/Ca).gw], latitude and longitude of provincial capitals ([Lat.cap], [Long.cap]) and soil-type index: proportion of moraines in coarse mineral soil samples [Prp.(mor/coms)].

Results: Explanation percent (R square in percents), significance, beta coefficient signs (& their ratio, in combined regressions).

a. [(Ca+Mg).gw] explained Keto.(94-96) by 56.7 % (p = 0.005)(-); CHD by 65.7 % (p = 0.001)(-), Ca.gw by 95.8 % (p < 0.001)(+) and Mg.gw by 5.2 %,ns,(+). CHD explained Keto.(94-96) by (49.1 %, p = 0.011)(+).

b. [(Ca+Mg).gw; Si.gw] explained Keto.(94-96) by 60.2 % (p = 0.016)(-;-)(80:20) and CHD by 81.0 % (p = 0.001)(-;-)(69:31). [(Ca+Mg).gw;(Mg/Ca).gw] explained them somewhat more weakly, but with similar beta coefficient ratios.

c. [Lat.cap; Long.cap] explained Keto.(94-96) by 55.1 % (p = 0.027)(+;+)(56:44) and CHD by 96.9 % (p < 0.001)(+;+)(22:78). [Lat.cap;Prp.(mor/coms)] explained Keto.(94-96) by 55.9 % (p = 0.025) (+.+) (58:42) and CHD by 50.4 % (p = 0.042)(+.+) (45:55).

d. Keto.(79-93) (December values) associated weaker than Keto.(94-96) (whole year values) with the explaining parameters .

Conclusion: Regional CHD and Keto.(94-96) associated significantly with each other and factors associated with soil weathering.

Introduction

The sum of weathered/liberated Ca and Mg has been used as a measure for estimation of consumption of atmospheric CO_2 [1]: "… only the weathering of Ca and Mg silicates is important for the global C cycle…". Weathering of silicates consumes CO_2 [1] and produces HCO_3^- and silicic acid [2], i.e. orthosilicic acid [Si(OH)$_4$] [3] and cations: K, Mg [4] and Ca [1]. Example: Mg2SiO4

+ 4 CO_2+ 4 H_2O ⇌ 2 Mg^{2+} + 4 HCO_3+ H_4SiO_4 [i.e. Si(OH)$_4$], in this article Si.gw [2]. (Weathering of one molecule of Ca- or Mg-silicate consumes 4 molecules CO2). Gaillardet et al. [1] estimated that silicate weathering consumes annually ca 58 Mt carbon [1] so working against soil acidification. Ketosis, Acetonaemia, (Keto) "typically occurs in dairy cows in early lactation and is most

consistently characterized by partial anorexia and depression" [5]. "The pathogenesis of bovine ketosis is incompletely understood, but it requires the combination of intense adipose mobilization and a high glucose demand. Both of these conditions are present in early lactation" [5].

This study is assessing geographic associations of Keto and (male) CHD (from 1964-84) with weathering related: groundwater (gw) hardness [(Ca+Mg).gw] [1], Si(OH)4 [Si.gw] [2,3], (soil-type related) [(Mg/Ca).gw] [6], (temperature-related) [Lat.cap], (soil age related) [Long.cap] [7] and soil coarsenes index [Prp.(mor/coms)].

Materials and Methods

Map and label numbers of Finnish Provinces are from [8], but they are put to the same order as respective RC's in [6,7]: (08 Kuopio before 07 North Karelia and 03 Åland as the last province). Periods

are represented by their two last numbers, e.g. (79-93) for 1973-93). Number of dairy cows (cows) for December 1983, as a measure of cattle, are readily by provinces from [9]. Provincial data for May 1995 are formed, if needed, by combining data of Rural Business Districts (labeled as Rural Centers) [10] as follows: 02 Turku and Pori (= Turun+Satakunnan), 04 Häme (= Hämeen+Pirkanmaan), 10 Vaasan (= E-Pohjanm. + "Vaasan" + 2/3*K-Pohjanm.), 11 Oulun (= 1/3*K-Pohjanm.+Oulun+Kainuun). Other data was readily given, e.g. Åland. Data of December 1983 was adjusted to June 1983 (nearer, but not just to May 1983) by multiplying the provincial numbers from December 1983 [9,10] by 1.046, i.e. the ratio of total number (thousands) of dairy cows in May 1983 [11] (663.1) and December 1983 (634.2) [9]. Total number of dairy cows for 1979 is from [12], for 1980-1996 from [11]. Provincial cow number estimates for other than 1983 and 1995 are attained after that by linear interpolation by total cow number [11,12]. Total number of cows was reduced by 46 % during the study period (Table 1).

Table 1: Estimated number of dairy cows (1,000) of Finnish provinces in 1979-1996 and their relative ratio to respective number of 1979.

	01 Uusimaa	02 Turku and Pori	04 Häme	05 Kymi	06 Mikkeli	08 Kuopio	07 North. Karelia	09 Central Finland	10 Vaasa	11 Oulun	12 Lapland	03 Åland	Tot	Cows.(i/1979)
79.appr	37.3	69.3	68.2	56.1	54.0	51.6	80.1	42.8	136.3	104.9	26.1	3.4	730.1	1.00
81.appr	35.8	66.5	65.5	53.9	51.8	49.5	76.9	41.0	130.8	100.7	25.1	3.2	700.8	0.96
1983.Jun.adj	33.9	62.9	62.0	51.0	49.0	46.9	72.8	38.8	123.8	95.3	23.7	3.0	663.1	0.91
85.ipol	31.3	57.2	58.6	47.0	45.0	46.7	65.2	36.1	118.1	88.7	22.4	2.9	619.1	0.85
89.ipol	26.0	45.7	51.8	39.0	37.0	46.3	49.9	30.5	106.8	75.6	19.7	2.7	530.9	0.73
91.ipol	23.4	39.9	48.4	35.0	32.9	46.1	42.3	27.7	101.2	69.0	18.3	2.6	486.8	0.67
92.ipol	22.1	37.0	46.7	33.0	30.9	46.0	38.4	26.4	98.4	65.7	17.6	2.6	464.8	0.64
93.ipol	20.8	34.2	45.0	31.0	28.9	45.9	34.6	25.0	95.5	62.4	17.0	2.5	442.8	0.61
94.ipol	19.5	31.3	43.3	29.0	26.9	45.8	30.8	23.6	92.7	59.1	16.3	2.5	420.7	0.58
1995.May.(by RC)	18.2	28.4	41.6	27.0	24.9	45.7	27.0	22.2	89.9	55.8	15.6	2.4	398.7	0.55
96.appr	17.9	27.9	40.9	26.6	24.5	45.0	26.6	21.8	88.4	54.9	15.3	2.4	392.2	0.54

Data on incidental cases of Ketosis (Keto) are from the same source [13] as HMg and HCa in [9]. Given numbers of (94-96) are readily divided by 12, so all numbers in (Table 2) represent monthly incidence. Annual/inter-periodical variation predicted by Pearson correlations was rather small (Table 2). (Table 3) represents Keto. (79-93) and Keto.(94-96) and their provincial ratio with national means. Periodical values are attained by dividing means of periodical cases by means of periodical number of dairy cows. Keto showed inter-periodically a decreasing trend, on an average ca 30 %, only in Northern Karelia Keto number was higher in (94-96) to (79-93) (Table 3). Age adjusted CHD mortality estimates of middle-

aged men in 1964-84 is attained from [6], originally from [14] (Table 4). Latitude and longitude of Finnish provinces are attained via internet by the names of the provincial capitals (Table 4) and "Wikipedia". Minutes (') and seconds ('') are changed to degrees by the author (Table 4). Provincial groundwater calcium, magnesium and silicon are as such, not composed by samples of Rural Centers, but changed to milliequalents (mEq/l) from Geological Survey of Finland [15], totaling 753 samples (Table 4). Soil-type index [Prp. (mor/coms)] is the numerical ratio of cropland moraine (mor) samples (N 98,271) per samples from coarse mineral soils (coms) total (N 318,788).

Table 2: Estimated number of dairy cows (1,000) of Finnish provinces in 1979-1996 and their relative ratio to respective number of 1979.

0	01 Uusimaa	02 Turku and Pori	04 Häme	05 Kymi	06 Mikkeli	08 Kuopio	07 North. Karelia	09 Central Finland	10 Vaasa	11 Oulu	12 Lapland	03 Åland	Mean	SD	Pearson[x.i;x.(i+1)]	μ (i = 1979, ...1989)
1979	174	319	379	698	304	511	229	204	803	657	170	19	372	244	0.91	
1981	178	406	391	370	233	439	193	228	791	678	177	30	343	219	0.92	
1983	187	343	337	315	292	614	224	240	745	806	371	18	374	233	0.96	
1985	103	264	299	351	341	470	226	216	731	767	197	33	333	225	0.96	
1989	75	231	230	201	248	381	139	122	438	598	197	4	239	165	0.94	0.94
1991	64	244	210	172	235	329	176	159	383	424	66	7	206	128	0.96	
1992	67	190	145	177	190	349	131	110	427	419	105	7	193	135	0.97	
1993	77	155	226	214	230	366	153	153	426	501	94	6	217	147	0.98	
1994	65	145	210	188	174	293	137	122	434	401	107	5	190	129	1.00	
1995	46	126	145	125	123	213	93	81	322	308	66	4	138	98	0.99	
1996	34	86	103	85	101	179	72	79	257	257	69	2	110	80	0.99	

Table 3: Provincial Keto, (1/100,000), per month by periods and their national means and ratio of provincial cases of (94-96) to those of (79-93) by province and their national mean.

	01 Uusimaa	02 Turku and Pori	04 Häme	05 Kymi	06 Mikkeli	08 Kuopio	07 North. Karelia	09 Central Finland	10 Vaasa	11 Oulu	12 Lapland	03 Åland	Mean
Keto.(79-93).Dec	401	521	497	722	629	913	320	534	521	732	811	540	595
Keto.(94-96).(1/12)	261	407	363	483	522	501	357	417	374	569	512	148	410
Keto.(94-96)/Keto.(79-93)	0.65	0.78	0.73	0.67	0.83	0.55	1.12	0.78	0.72	0.78	0.63	0.27	0.71

Table 4: Finnish provinces, provincial capitals, CHD mortality of middle-aged men, latitude, longitude of provincial capitals, groundwater Ca, Mg, Si, (Ca+Mg) and (Mg/Ca) with means and soil-type coarseness, [Styp.coars] (proportion of moraine samples per samples from all coarse mineral soils) (coarse mineral soils = moraines and sands).

Province	Provincial Capitals	Male CHD	Latit.cap	Longit.cap	Ca.gw	Mg.gw	Si.gw	(Ca+Mg).gw	(Mg/Ca).gw	[Prp.(mor/coms)]
		1/100,000	°N	°E	mEq/l			(mEq/l)		
01 Uusimaa	**Helsinki**	447	60.2	24.9	1.03	0.54	1.08	1.57	0.534	0.212
02 Turku and Pori	**Turku**	386	60.5	22.3	0.94	0.49	1.06	1.43	0.496	0.181
04 Häme	**Hämeenlinna**	414	61.0	24.5	0.79	0.45	1.05	1.24	0.558	0.182
05 Kymi	**Kouvola**	511	60.9	26.7	0.77	0.31	0.99	1.08	0.400	0.304
06 Mikkeli	**Mikkeli**	531	61.7	27.3	0.87	0.27	0.95	1.14	0.306	0.772
08 Kuopio	**Kuopio**	564	62.9	27.7	0.65	0.21	0.79	0.86	0.317	0.515

07 North. Karelia	**Joensuu**	622	62.6	29.8	0.55	0.18	0.80	0.73	0.330	0.345
09 Central Finland	**Jyväskylä**	515	62.2	25.7	0.53	0.16	0.89	0.69	0.328	0.462
10 Vaasa	**Vaasa**	370	63.1	21.6	0.75	0.3	1.18	1.05	0.403	0.131
11 Oulu	**Oulu**	553	65.0	25.5	0.75	0.26	0.78	1.01	0.347	0.239
12 Lapland	**Rovaniemi**	529	66.5	25.7	0.57	0.23	0.70	0.80	0.409	0.413
03 Åland	**Mariehamn**	265	60.1	19.9	2.74	0.22	0.69	2.96	0.081	0.193
Mean		476	62.2	25.1	0.912	0.302	0.91	1.21	0.376	0.329

Data by Rural Centers (RC) are available most easily from [16], originally from [17]. Provincial data are attained by weighting cropland values by the cropland areas by RC's , which are totally inside of the province [6], but areas of Pirkanmaa, Itä-Häme and K-Pohjanmaa (Central Ostrobothnia), which are located in 2-3 provinces are multiplied by 0.7 before weighting (Table 4). After that weighting provincial Prp.(mor/coms) was got by dividing provincial Prp.mor by Prp.coms. Factors of (combined) regressions are in square brackets: [].

Results

Results are given in order: explanation percent (R square in percents), significance, beta coefficient sign(s) (& ratio of their absolute values, in combined regressions).

a.   [(Ca+Mg).gw] explained [Keto.(94-96)] by 56.7 % (p = 0.005)(-); [CHD] by 65.7 % (p = 0.001)(-), [Ca.gw] by 95.8 % (p < 0.001)(+), Mg.gw by 5.2 %,ns,(+), [Latit.cap] by 32.2 % (p = 0.054)(-) and [Long.cap] by 51.6 % (p = 0.009)(-).

b.   [Keto.(94-96)] was explained 49.1 % (p = 0.011)(+) by CHD (Figure 1); 40.5 % (p = 0.026)(+) by [Lat.cap], 30.8 % (p = 0.061)(+) by [Long.cap]. [CHD] was explained 26.5 % (p = 0.087)(+) by [Lat.cap] and 91.1 % (p < 0.001)(+) by [Long.cap] Fig.1 represents Keto.(94-96) and its regression by CHD.

c.   [(Mg/Ca).gw] explained [Si.gw] by 45.6 % (p = 0.016)(+). (Combined regression by) [Lat.cap;(Mg/Ca).gw] explained [Si.gw] by 62.8 % (p = 0.012)(-;+)(39:61). Si.gw of Vaasa does not comply with the regression. (Figure 2).

d.   [(Ca+Mg).gw; Si.gw] explained Keto.(79-93) by 23.8 % (p = 0.295)(-;-)(38:62); Keto.(94-96) by 60.2 % (p = 0.016)(-;-)(80:20) and CHD by 81.0 % (p = 0.001)(-;-)(69:31). (Table 5, Figures 3-5). Regional mean of CHD and Keto.(79-93) and Keto.(94-96) are of the same magnitude. ca 400 – 600 (1/100,000).

e.   Remarkable is the low number of Keto cases in North Karelia.

f.   Respectively [(Ca+Mg).gw;(Mg/Ca).gw] explained Keto.(79-93) by 12.4 % (p = 0.551)(-;-)(53:47), Keto.(94-96) by 57.9 % (p = 0.020)(-;-)(87:13) and CHD by 72.8 % (p = 0.003)(-;-)(76:24). (Table 6).

g.   [Lat.cap; Long.cap] explained Keto.(79-93) by 26.9 % (p = 0.245)(+;+)(100:0.04), Keto.(94-96) by 55.1 % (p = 0.027)(+;+)(56:44) and M.CHD by 96.9 % (p < 0.001)(+;+)(22:78), (Table7, Figures6 & 7).

h.   [Lat.cap; Prp.(mor/coms)] explained Keto.(79-93) by 34.9 % (p = 0.145)(+;+)(61:39), Keto.(94-96) by 55.9 % (p = 0.025)(+;+)(58:42) and M.CHD.(64-84) by 50.4 % (p = 0.042) -(+;+)(45:55).
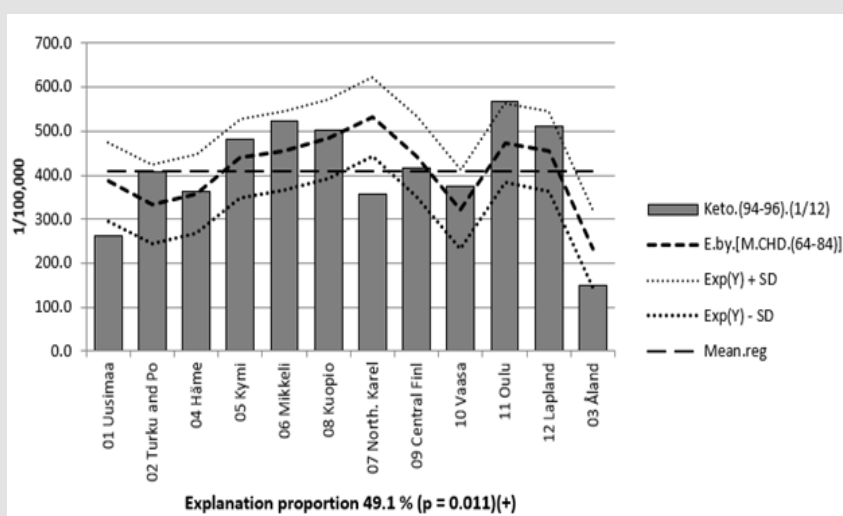
Figure 1: Keto.(94-96) and its regression by male CHD .(64-84).
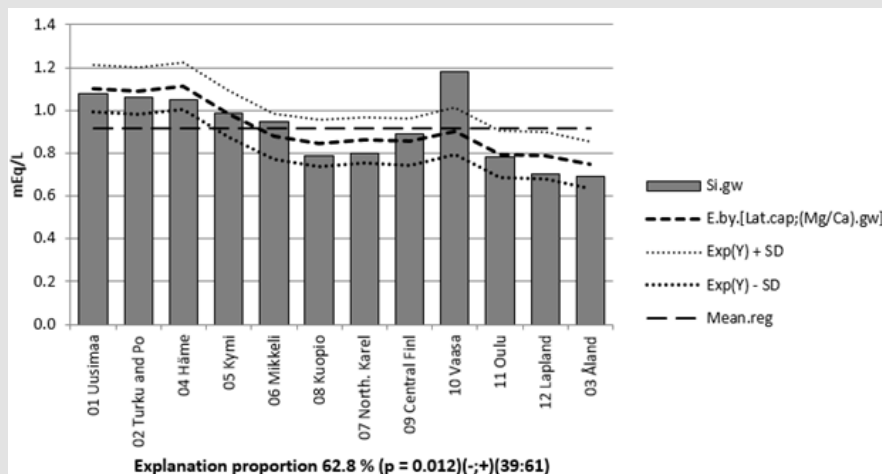
Figure 2: Si.gw and its regression by [Lat.cap;(Mg/Ca).gw].
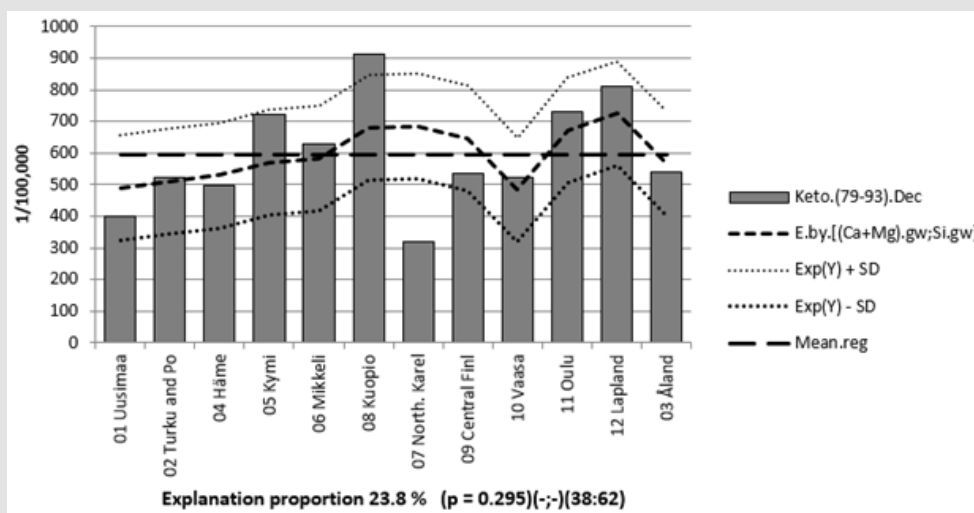
Figure 3: Keto.(79-93) and its regression by [(Ca+Mg).gw;Si.gw].
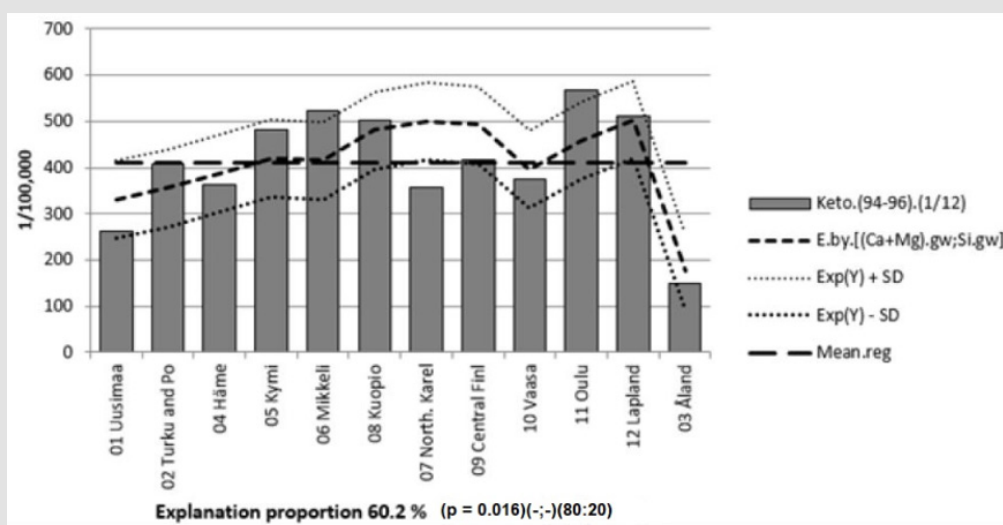
Figure 4: shows Keto.(94-96) and its regression by [(Ca+Mg).gw;Si.gw].
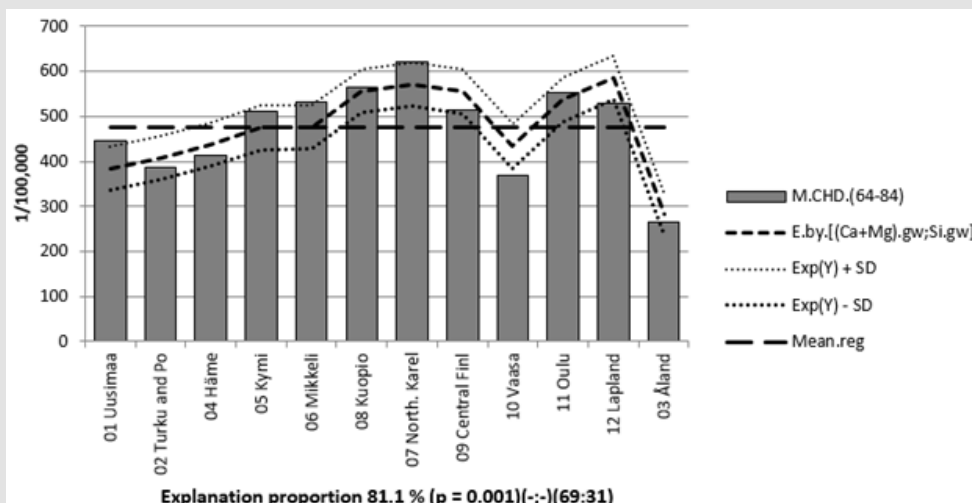
Figure 5: Male CHD.(64-84) and its regression by [(Ca+Mg).gw;Si.gw].
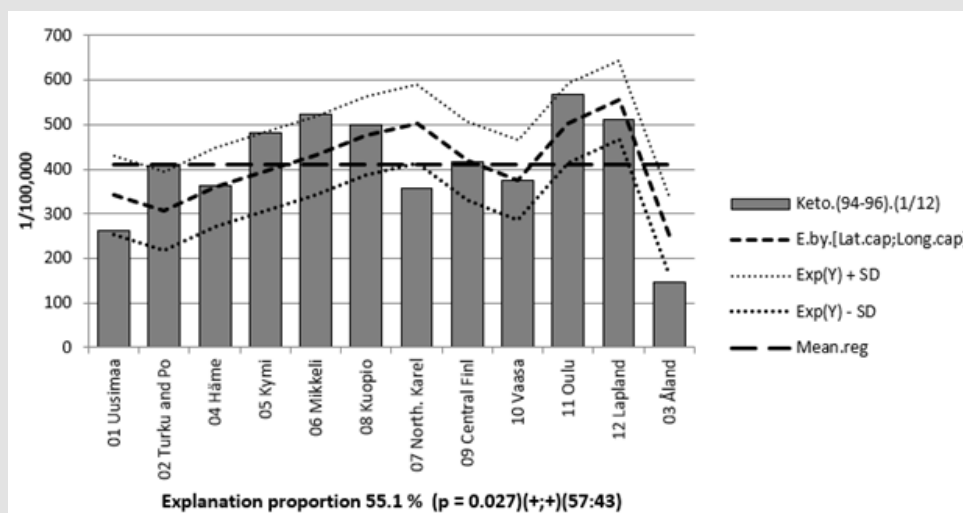
Figure 6: Keto.(94-96) and its regression by [Latit.cap;Longit.cap].
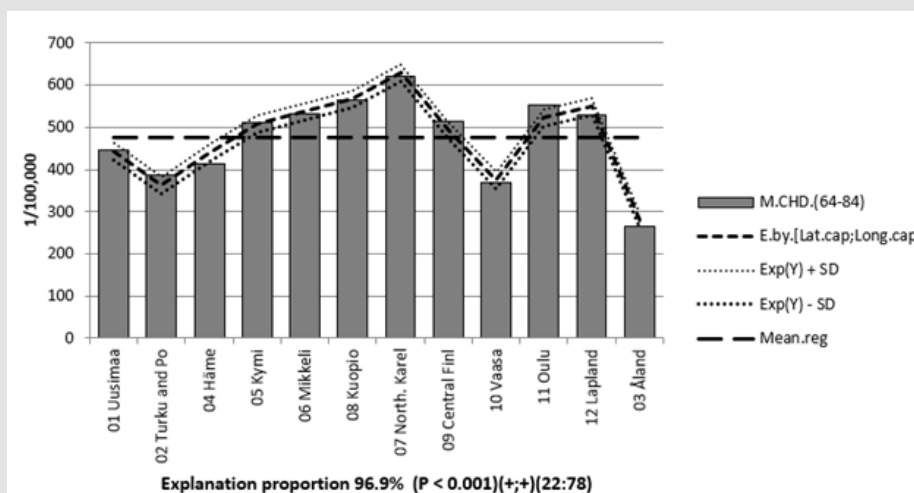
Figure 7: Male CHD.(64-84) and its regression by [Lat.cap;Long.cap].
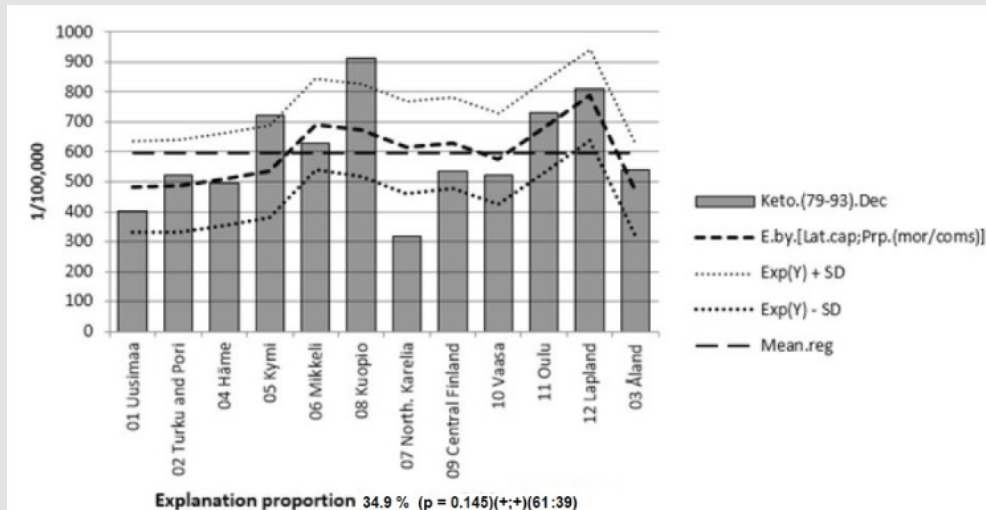
Figure 8: Keto.(79-93) and its regression by [Lat.cap; Prp.(mor/coms)].
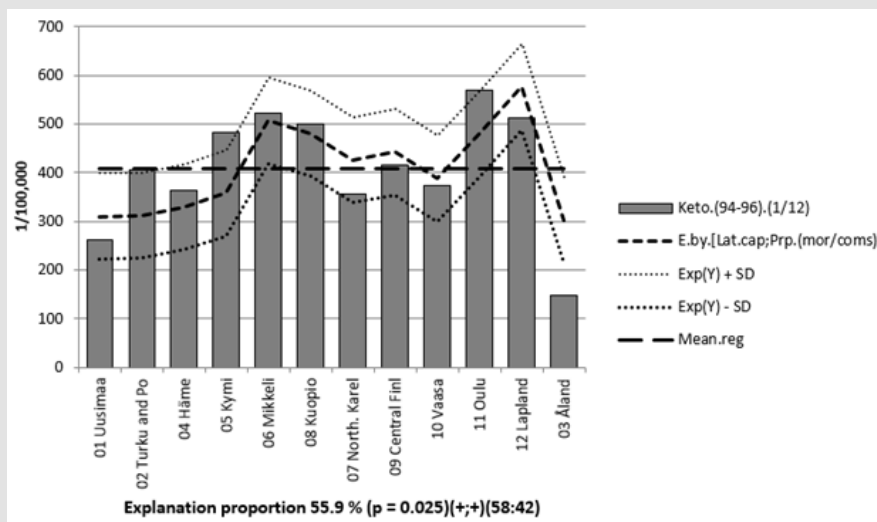
Figure 9: Keto.(94-96) and its regression by [Lat.cap; Prp.(mor/coms)].
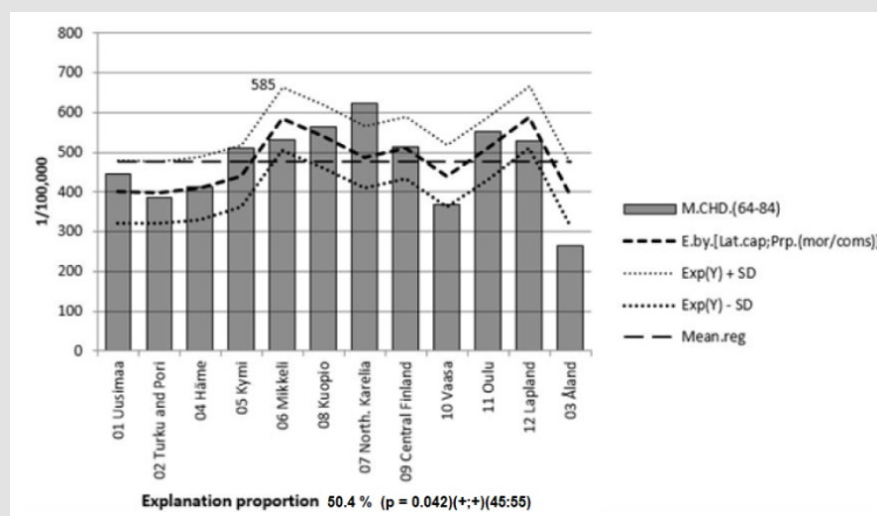
Figure 10: M.CHD.(64-84) and its regression by [Lat.cap;Prp.(mor/coms)].

Discussion

Combined regressions by factors associated with soil weathering in Finland {[(Ca+Mg).gw;Si.gw]; [(Ca+Mg).gw;(Mg/Ca).gw]; [Lat.cap;Long.cap] and [Lat.cap;Prp.(mor/coms)]} explained significantly Keto.(94-96) and CHD, somewhat similarly, but weaker Keto.(79-93). In general CHD was more significantly explained by the combined regressions, but Keto.(94-96) complied better with regression by [Lat.cap;Prp.(mor/coms)] (Tables 5-8). The indicator of weathering: water hardness (Ca+Mg) explained significantly Keto.(94-96) [by 56.7 % (p = 0.005), (-)] and M.CHD.(64-84) [by 65.7 % (p = 0.001),(-)]. Addition of explaining factors (Mg/Ca).gw and Si.gw strengthened the associations, by Si.gw more than by (Mg/Ca) (Tables 5 & 6). High correlation between Ca.gw and (Ca+Mg).gw (higher than by Mg.gw) indicates, that Ca.gw can be used at least in Finland, as an indicator of gw hardness.

We can ask: why the weathering products, (Ca+Mg).gw and Si.gw, do not correlate well in Åland, when they are quite well correlated in continental Finland. Answers: in Åland (Ca+Mg).gw is produced from two sources: carbonates and silicates [18], and moderately high pH obviously has reduced Si.gw content [6]. Carbonates indicate soil-type juvenility (and non-podsol soil-types) [19], (i.e. better weatherability). High sum of cations suggests on sustaining factor(s), silicates, or clay material [20].

Table 5: Combined regressions of Keto.(79-93), Keto.(94-96) and CHD by [(Ca+Mg).gw;Si.gw] their R squares, significances and signs and ratios of beta coefficients (by absolute values).

	R squares (%)	Signif.	Signs	Ratio of beta coefficients
12.Keto.(79-93)	23.8	0.295	(-;-)	38:62
12.Keto.(94-96)	60.2	0.016	(-;-)	80:20
12.M.CHD.(64-84)	81.0	0.001	(-;-)	69:31

Table 6: Combined regressions of Keto.(79-93), Keto.(94-96) and CHD by [(Ca+Mg).gw;(Mg/Ca).gw], their R squares, significances, signs and ratios of beta coefficients (by absolute values).

	R squares (%)	Signif.	Signs	Ratio of beta coefficients
12.Keto.(79-93)	12.4	0.551	(-;-)	53:47
12.Keto.(94-96)	57.9	0.020	(-;-)	87:13
12.M.CHD.(64-84)	72.8	0.003	(-;-)	76:24

Table 7: Combined regressions of Keto.(79-93), Keto.(94-96) and CHD by [Lat.cap;Long.cap], their R squares, significances, signs, and ratios of beta coefficients (by absolute values).

	R squares (%)	Signif.	Signs	Ratio of beta coefficients
12.Keto.(79-93)	26.9	0.245	(+;+)	100:0.04
12.Keto.(94-96)	55.1	0.027	(+;+)	56:44
12.M.CHD.(64-84)	96.9	< 0.001	(+;+)	22:78

Table 8: Combined regressions of Keto.(79-93), Keto.(94-96) and CHD by [Lat.cap; Prp.(mor/coms)], their R squares, significances, signs and ratios of beta coefficients (by absolute values).

|	R squares (%)	Signif.	Signs	Ratio of beta coefficients
12.Keto.(79-93)	34.9	0.145	(+;+)	61:39
12.Keto.(94-96)	55.9	0.025	(+;+)	58:42
12.M.CHD.(64-84)	50.4	0.042	(+;+)	45:55

[(Mg/Ca).gw] has explained significantly inversely M.CHD in continental Finland in several studies, as in [17]. But [(Mg/Ca).soil], which has been thought to be the influential factor, generally explained CHD remarkably more weakly, or not at all [19]. In north Finland, including 22 % of Finnish cultivated soil [6] and 25 % soil samples [16], (Mg/Ca) of soil did not comply with (Mg/Ca).gw, but in whole Finland gw and soil (Mg/Ca) explained significantly (p = 0.006) each other, calculated by data in [17]. Provincial [(Mg/Ca).gw] value of Åland, based only on six samples [15], could be rejected, because of statistical reasons, but it complies with cropland (Mg/Ca), based on 4,200 soil samples [16,17-21]. (Mg/Ca) gw and soil got their lowest provincial value in Åland, where the CHD mortality of middle-aged men was the lowest (every year) between 1964 and 1984 [14]. On the other side the HCl-soluble Mg reserves can be the highest in carbonate soils [22]. Anyhow Finnish provincial (Mg/Ca) of timothy has been the lowest in Åland [23], which suggests that high Mg availability cannot explain the low CHD mortality in Åland. (Mg/Ca).gw explained significantly Si.gw by 45 % and together with latitude by 64 % (p = 0.010) (Figure 2). High (Mg/Ca) ratio indicates not only on soil-type, but the same time on soil content of clay material [21].

Temperature (here latitude) can promote soil weathering (and production of $Si(OH)_4$ and Mg, Ca and K cations [1-4]). This explains, why in (Figure 2) [Lat.cap] fortified the explanation of Si.gw by (Mg/Ca).gw. (Figure 2) suggests that high Si.gw of Vaasa could be based on statistical bias, as by Ostrobotnia, included in Vaasa [17] or soil pH [6]. Possible explanation, why (Ca+Mg) is a better measure for weathering [1] than (Mg/Ca), is that $Si(OH)_4$ and cations can be produced not only from clay material, but even from such granite components, which produce cations in different proportions to clay [24]. Latitude and longitude increased both Keto and CHD risk. (Table 7). [Latit.cap] explained (Ca+Mg).gw by 32.2 % (p = 0.054)(-) and [Longit.cap] by 51.6 % (p = 0.009)(-). So (Ca+Mg).gw can be included to "east risk factors". (It was more strongly associated with longitude than (Ca+Mg).soil. This can be calculated e.g. data in [6]) Combined regression by [Lat.cap;Long.cap] explained CHD better than the gw factors. Both Keto series associated stronger with latitude than with longitude, oppositely to CHD. Latitude is associated with shorter pasture period and shorter period to get fresh grass and with less effective weathering (temperature dependent). Longitude is associated with soil age: period open for weathering and erosion (erosion = weathering +

transport), additionally associated with altitude and higher number of rainy days [25] and so obviously with lower level in vitamin D synthesis in the skin.

Explanation for rainy days is the higher altitude in the eastern regions [25]. Earth elevation in the western Finland has been ca 250 m during the last 9,000 yrs [26]. Earth elevation moved the southern coast northwards, so that elevation was not purely east-west phenomenon. (Elevation affected on Altitude, which could possibly be a better factor to longitude if it could be properly determined.) The lower areas have been receivers of minerals and the higher areas have been losers. These parameters are largely explained by gw (and soil) parameters, but factor longitude possibly needs other explanations, as vitamin D and genetic factors by humans. It seems that in interpretation of effects of genetic factors, other geographic factors need assessment. It is obvious that cattle ketosis was not caused by the same genes as human CHD. Combined regression by temperature and soil-type indicators: [Lat.cap;Prp.(mor/coms).88], (Table 8), explained better Keto.(94-96) than CHD. Relative weights of these factors were nearer each other than in other combined regressions. [(Ca+Mg).gw] is an indicator of weathering but cannot tell as well as the (Ca+Mg) of the rivers [1] about the speed of its formation (weathering/erosion rate). Obviously estimated CO_2 consumption via silicate weathering ca 200 Mt/yr (58 Mt C/yr) [1] is an underestimation because coarse soil fragments, including stones, have a much higher short term impact on nutrient input than previously thought based on weathering rates, [27].

Obviously, inorganic soil tests results can be used only as (lower) estimates of weathering. The biological function of soil (or its potential) seems to be underestimated. In cattle ketosis low grade inflammation and problems in intestinal integrity (so called "leaky gut") is believed to be the source of LPS infiltration and cause of systemic inflammation [28]. I.e. in cattle Ketosis structural factors and inflammation can be associated with silicon as in atherosclerosis of humans [29]. Anyhow veterinary surgeon Haaranen wrote that in the prophylaxis and treatment of cattle Ketosis the "only healthy procedure for reinforcement/supply of blood sugar is to guide fermentation in rumen to produce more propionic acid and reduce formation of acetic acid so that their proportions would be 1:1 [30]. He wrote that traditionally farmers had given Ketose cows moldy hay (which cows eagerly ate [30]) and that after rainy summers 1954, 1962, 1967 and 1974 incidence of cattle ketoses was unusually low. (Haaranen wrote that these observations on moldy hays are not yet given as a recommendation," before studies have given more knowledge on bacterium-mold ratios in soil, plant, fodder and rumen, as well as on fermentation processes in rumen" [30]). In 1974 was discovered in USA, that moldy hay contains monensin, produced by a mold Streptomyces cinnamonensis, which can increase relatively propionic acid production by 50 % [30]. Monensin is not available in all countries [5].

On the other hand, via changes in fodder quality and delivery, cattle Ketosis is nearly totally disappeared until today in Finland [31]. Remarkable was the low Keto during both periods in Northern Karelia (e.g. Figures 3 & 4), (caused by monensin?).

Open question has been the low CHD mortality in Åland, which is associated with highest provincial (Ca+Mg).gw and lowest (gw and) cropland (Mg/Ca) in Finland [17]. Earlier (2018) (semi-skimmed) milk contents of acid-soluble Si in seven Finnish dairy samples was 90 (+/-83) ppm (mg/kg), in Åland 133 (+/- 120) ppm and in continental Finland 58 (+/- 17) ppm. Results varied between 30 -270 ppm: highest in July (Åland) and lowest in October (Åland) [32,33]. This year, between April 21 and Sept 3, were analyzed together 25 samples of semi-skimmed milk from Åland and continental Finland. Milk samples of continental Finland were collected by a dairy locating in a region of southern Finland, where Si.gw, (Ca+Mg).gw and (Mg/Ca).gw were remarkably higher than the regional mean of the whole country. Anyhow area of milk collection included several regions, why these associations cannot be benefited as such (or not at all) in conclusions. 40 % of the results were below the detection threshold. "<2" ppm. After replacing "<2" by 1, the whole country mean of acid soluble Si of semi-skimmed milk was 1.9 (+/- 0.86) ppm, no clear differences was found between continental (1.9 +/- 0.83) and Åland (1.9 +/- 0.94) values nor caused by agricultural practices (organic or conventional).

(Benefiting of silicate amendments seems not to be a standard routine in organic nor conventional agriculture). The analyze method was checked by Eurofins: no differences were found between analyze methods of 2018 and 2020 [32]. The difference between 2018 and 2020 could obviously be explained by the very dry and hot weather in summer 2018: The temperature was 2.1 °C above the normal and rainfall (precipitation) 46 % below the normal [34]. Low precipitation affected especially the west Finland as Åland ("rainfall was unusually low in the western half of the country" [35]. The author was reported that the yield of crops in Åland was only about 50 % from normal. These could have caused increased weathering via the elevated temperature and need of plants to take water and nutrients from groundwater and deeper soil layers than usually. Although the Si values in 2018 were ca 50 times higher than in 2020, they were related with each other as Australian wheat (500 - 5,000 ppm) to Finnish wheat (50 – 100 ppm) [33,36]. Results from 2018 and 2010 together: 1) Temperature can effect on Si content of milk (and plants) as suggested in [33]. 2) Si content of milk and other food in Åland can be, independent of lower Si.gw value as high as (or higher than) in continental Finland.

More accurate determination of geographic milk origin (or farm related samples contra mean dairy samples), history of agricultural practices and silicate supplementation, soil-type distribution, and temperature during 1-3 days before sampling are needed in the further studies. Acid-soluble and water-soluble Si are suggested to be analyzed separately, coincidentally.

Benefits of weathering are associated with mineral elements existing in or supplemented to the croplands. Active weathering can release besides of Si even tin (Sn). Both of them have geographic associations with CHD, musculoskeletal diseases, and chemical associations with mucopolysaccharides (glycosaminoglycans, GAG) [29].

Conclusion

Regional CHD and Keto.(94-96) associated significantly with each other and factors associated with soil weathering. Milk Si can be associated with local weathering rate of silicates and is suggested to become one candidate for the measures of farm relating CO2 consumption.

Acknowledgement

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